THE

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Conducted by Members of the Catholic University of Ireland.

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THE

ATLANTIS.

Art. I.—*The Mission of the Benedictine Order.*

Agency and influence of Persons

As the physical universe is sustained and carried on in dependence on certain centres of power and laws of operation, so the course of the social and political world, and of that great religious organization called the Catholic Church, is found to proceed for the most part from the presence or action of definite persons, places, events, and institutions, as the visible cause of the whole. There has been but one Judæa, one Greece, one Rome; one Homer, one Cicero; one Cæsar, one Constantine, one Charlemagne. And so, as regards Revelation, there has been one St. John the Divine, one Doctor of the Nations. Dogma runs along the line of Athanasius, Augustine, Thomas. The conversion of the heathen is ascribed, after the Apostles, to champions of the truth so few, that we may almost count them, as Martin, Patrick, Augustine, Boniface. Then there is St. Antony, the father of monachism; St. Jerome, the interpreter of Scripture; St. Chrysostom, the great preacher.

in Christian Civilization.

Education follows the same law: it has its history in the Church, and its doctors or patriarchs in that history. This is the subject on which we propose to make some remarks in the pages which follow, taking Education in its broadest and most general sense, as the work contemplated in the august command, "Go, teach all nations", and as more or less connected with civilization, social advance, the cultivation of learning, sacred and profane, and similar great facts, which are its historical interpretation.

Of three especially:

Benedict, Dominic, Ignatius,

The outline of what we have to say on the subject is simple enough; it is the filling up of details, which will demand diligence in the writer, and patience in the reader. There are three main periods, then, of ecclesiastical history,—the ancient, the medieval, and the modern; so far is plain: and there are three Religious Orders in those periods respectively, which succeed, one the other, on the public stage, and represent the teaching of the Catholic Church during the time of their ascendancy. The first period is that long series of centuries, during which society was breaking, or had broken up, and then slowly attempted its own re-construction; the second may be called the period of re-construction; and the third dates from the Reformation, when that peculiar movement of mind commenced, the issue of which is still to come. Now, St. Benedict is the Patriarch of the ancient world; St. Dominic of the medieval; and St. Ignatius of the modern. And in saying this, we are in no degree disrespectful to the Augustinians, Carmelites, Franciscans, and other great religious families, which might be named; for we are not reviewing the whole history of Christianity, but selecting a particular aspect of it.

with their respective characteristics,

Perhaps as much as this will be granted to us without great hesitation. Next we proceed, after thus roughly mapping out our view of history, roughly to colour it, by way of contrasting these three patriarchs of Christian teaching with each other. To St. Benedict then, who may fairly be taken to represent the various families of monks before his time and those which sprang from him (for they are all pretty much of one school), to this great saint let us assign, for his discriminating badge, the Poetical; to St. Dominic, the Scientific; and to St. Ignatius, the Practical and Useful.

corresponding to their respective histories,

These characteristics, which belong respectively to the works of the three great Masters, grow out of the circumstances under which they respectively entered upon them. Benedict, entrusted with his mission almost as a boy, infused into it the romance and simplicity of boyhood. Dominic, a man of forty-five, a graduate in theology, a priest and a canon, brought with him into religion the maturity and completeness of learning, which he had acquired in the schools. Ignatius, a man of the world before his conversion, transmitted as a legacy to his disciples that knowledge of mankind which cannot be learned in cloisters. And thus the three several Orders were (so to say) begotten in Poetry, Science, and Good Sense.

calling to mind the theory of the "three stages of evolution",

And here another coincidence suggests itself. We have been giving these three attributes to the three Patriarchs severally, from a *bonâ fide* regard to their history, and without at all having any theory of philosophy in our eye. But, after having so described them, it certainly did strike us that we had unintentionally been illustrating a somewhat popular notion of the day, the like of which is attributed to authors, with whom we have as little sympathy as with any persons who can be named. According to these speculators, the life, whether of a race or of an individual of the great human family, is divided into three stages, each of which has its own ruling principle and characteristic. The youth makes his start in life, with "*hope* at the prow, and *fancy* at the helm"; he has nothing else but these to impel or direct him; he has not lived long enough to exercise his reason, or to gather in a store of facts; and, because he cannot do otherwise, he dwells in a world which he has created. He begins with illusions. Now, facts are external to him, but his reason is his own: of the two, then, it is easier for him to exercise his reason than to ascertain facts. Accordingly, his first mental revolution, when he discards the life of aspiration and affection, which has disappointed him, and the dreams of which he has been the sport and victim, is to embrace a life of logic: this then is his second stage,—the metaphysical. He acts now on a plan, thinks by system, is cautious about his middle terms, and trusts nothing but what takes a scientific form. His third stage is when he has made full trial of life; when he has found his theories break down under the weight of facts, and experience falsify his most promising calculations. Then the old man recognizes at length, that what he can taste, touch, and handle, is trustworthy, and nothing beyond it. Thus he runs through his three periods of Imagination, Reason, and Sense; and then he comes to an end, and is not;—a most impotent and melancholy conclusion.

but with an essential difference.

We repeat, we have no sympathy in so heartless a view of life, and yet it seems to square with what we have been saying of the three great Patriarchs of Christian teaching. And certainly there is a truth in it, which gives it its plausibility. However, we are not concerned here to do more than to put our finger on the point at which we diverge from it, in what we have been saying and must say concerning them. It is true, then, that history, as viewed in these three saints, is, somewhat after the manner of the theory we have mentioned, a progress from poetry through science to practical sense or prudence; but then this important *proviso* has to be borne in mind at the same time, that what the Catholic Church once has had, she never has lost. She has never wept over, or been angry with, time gone and over. Instead of passing from one stage of life to another, she has carried her youth and middle age along with her, on to her latest time. She has not changed possessions, but accumulated them, and has brought out of her treasure-house, according to the occasion, things new and old. She did not lose Benedict by finding Dominic; and she has still both Benedict and Dominic at home, though she has become the mother of Ignatius. Imagination, Science, Prudence, all are good, and she has them all. Things incompatible in nature, coëxist in her; her prose is poetical on the one hand, and philosophical on the other.

Mission of St. Ignatius too luminous to be discussed.

Coming now to the historical proof of the contrast we have been instituting, we are sanguine in thinking that one branch of it is already allowed by the consent of the world, and is undeniable. By common consent, the palm of Prudence, in the full sense of that comprehensive word, belongs to the School of Religion, of which St. Ignatius is the Founder. That great Society is the classical seat and fountain of discretion, practical sense, and wise government. Sublimer conceptions or more profound speculations may have been elaborated elsewhere; but, whether we consider the illustrious Body in its own constitution, or in its rules for instruction and direction, we see that it is its very genius to prefer this most excellent prudence to every other gift, and to think little both of poetry and of science, unless they happen to be useful. It is true that, in the long catalogue of its members, there are to be found the names of the most consummate theologians, and of scholars the most elegant and accomplished; but we are speaking here, not of individuals, but of the body itself. It is plain, that the body is not over-jealous about its theological traditions; or it certainly would not suffer Suarez to controvert with Molina, Viva with Vasquez, Passaglia with Petavius, and Faure with Suarez, de Lugo, and

Valentia. In this intellectual freedom its members justly glory; inasmuch as they have set their affections, not on the opinions of the Schools, but on the souls of men. And it is the same charitable motive, which makes them give up the poetry of life, the poetry of ceremonies,—of the cowl, the cloister, and the choir,—content with the most prosaic architecture, if it be but convenient, and the most prosaic neighbourhood, if it be but populous. We need not then dwell longer on this wonderful Religion, but may confine the remarks which are to follow, to the two Religions, which historically preceded it—the Benedictine and the Dominican.

Three Hebrew Patriarchs.

One preliminary more, suggested by a purely fanciful analogy:—As there are three great Patriarchs on the high road and public thoroughfare of Christian History, so there were three chief Patriarchs in the first age of the chosen people. Putting aside Noe and Melchisedec, and Joseph and his brethren, we recognize three venerable fathers,—Abraham, Isaac, and Jacob: Abraham, the father of many nations; Isaac the intellectual, living in solitary simplicity, and in loving contemplation; and Jacob, the persecuted and helpless, visited by marvellous providences, driven from place to place, set down and taken up again, illtreated by those who were his debtors, and maligned when he is innocent, yet carried on and triumphing amid all troubles by means of his most faithful and powerful guardian-archangel. We are exempted, by what has gone before, from the duty of completing our parallel, in the instance of Jacob; but, as to Benedictines and Dominicans, we shall introduce them successively under the type, as it may be called, of Abraham and Isaac.

St. Benedict prolific in monastic congregations,

St. Benedict, like the great Hebrew Patriarch, was the "Father of many nations". He has been styled "the Patriarch of the West", a title which there are many reasons for ascribing to him. Not only was he the first to establish a perpetual Order of Regulars in Western Christendom; not only, as coming first, has he had an ampler course of centuries for the multiplication of his children; but his Rule, as that of St. Basil in the East, is the normal rule of the first ages of the Church, and was in time generally received even in communities which in no sense owed their origin to him. Moreover, out of his Order rose, in process of time, various new monastic families, which have established themselves as independent institutions, and are able to boast in their turn of the number of their houses, and the sanctity and historical celebrity of their members. He is the representative of Latin monachism for the long extent of six centuries, while monachism was one; and even when at length varieties arose, and distinct titles were given to them, the change grew out of him;—not the act of strangers who were his rivals, but of his own children, who did but make a new beginning in all devotion and loyalty to him. He died in the early half of the sixth century; at the beginning of the tenth rose from among his French monasteries the famous Congregation of Cluni, illustrated by St. Majolus, St. Odilo, Peter the Venerable, and other considerable personages, among whom is Hildebrand, afterwards Pope Gregory the Seventh. Then came, in long succession, the Orders or Congregations of Camaldoli under St. Romuald, of Vallombrosa, of Citeaux, to which St. Bernard has given his name, of Monte Vergine, of Fontvrault; those of England, Spain, and Flanders; the Silvestrines, the Celestines, the Olivetans, the Humiliati, besides a multitude of institutes for women, as the Gilbertines and the Oblates of St. Frances, and then at length, to mention no others, the Congregation of St. Maur in modern times, so well known for its biblical, patristical, and historical works, and for its learned members, Montfaucon, Mabillon, and their companions. The panegyrists of this illustrious Order are accustomed to claim for it in all its branches as many as thirty-seven thousand houses, and, besides numerous Popes, 200 Cardinals, 4 Emperors, 46 Kings, 51 Queens, 1,406 Princes, 1,600 Archbishops, 600 Bishops, 2,400 Nobles, and 15,000 Abbots and learned men.[1]

and the adopted father of many more.

Nor are the religious bodies which sprang from St. Benedict the full measure of what he has accomplished,—as has been already observed. His Rule gradually made its way into those various monasteries, which were of an earlier or an independent foundation. It first coalesced with, and then supplanted, the Irish Rule of St. Columban in France, and the still older institutes which had been brought from the East by St. Athanasius, St. Eusebius, and St. Martin. At the beginning of the ninth century it was formally adopted throughout the dominions of Charlemagne. Pure, or with some admixture, it was brought by St. Augustine to England; and that admixure, if it existed, was gradually eliminated by St. Wilfrid, St. Dunstan, and Lanfranc, till at length it was received, with the name and obedience of St. Benedict, in all the Cathedral monasteries[2] (to make no mention of others), excepting Carlisle. Nor did it cost such regular bodies any very great effort to make the change, even when historically most separate from St. Benedict; for the Saint had taken up for the most part what he found, and his Rule was but the expression of the genius of monachism in those first ages of the Church, with a more exact adaptation to their needs, than could elsewhere be found.

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[1] Helyot, Hist. Mon. Ziegelbauer, Litt. Hist. Soame's Mosheim, vol. ii., p. 26. Buckingham's Bible in the Middle Ages, p. 81, etc., etc.

Recognizes the unity of the monastic idea.

So uniform indeed had been the monastic idea before his time, and so little stress had been laid by individual communities on their respective peculiarities, that religious men passed at pleasure from one body to another.[3] St. Benedict provides in his Rule for the case of strangers coming to one of his houses, and wishing to remain there. If such a one came from any monastery with which the monks had existing relations, then he was not to be received without letters from his Abbot; but, in the instance of " a foreign monk from distant parts", who wished to dwell with them as a guest, and was content with their ways, and conformed himself to them, and was not troublesome, " should he in the event wish to stay for good", says St. Benedict, " let him not be refused; for there has been room to make trial of him, during the time that hospitality has been shown him: nay, let him even be invited to stay, that others may gain a lesson from his example; for in every place we are servants of one Lord and soldiers of one King".[4]

Monastic unity in contrast to the multiform world.

The unity, which these words imply as the distinctive token of a monk in every part of Christendom, may be described as a unity of object, of state, and of occupation. Monachism was one and the same everywhere, because it was a reaction from that secular life, which has everywhere the same structure and the same characteristics. And, since that secular life contained in it many objects, many states, and many occupations, here was a special reason, as a matter of principle, why the reaction from it should bear the badge of unity, and should be in outward appearance one and the same everywhere. Moreover, since that same secular life was, when monachism arose, more than ordinarily marked by variety, perturbation, and confusion, it seemed on that very account to justify emphatically a rising and revolt against itself, and a recurrence to some state, which, unlike itself, was constant and unalterable. It was indeed an old, decayed, and moribund world, into which Christianity had been cast. The social fabric was overgrown with the corruptions of a thousand years, and was held together, not so much by any common principle, as by the strength of possession and the tenacity of custom. It was too large for public spirit, and too artificial for patriotism, and its many religions did but foster in the popular mind division and scepticism. Want of mutual confidence would lead to despondency, inactivity, and selfishness. Society was in the slow fever of consumption, which made it restless in proportion as it was feeble. It was powerful, however, to seduce and deprave; nor was there any *locus standi* from which to combat its evils; and the only way of getting on with it was to abandon principle and duty, to take things as they came, and to do as the world did. Worse than all, this encompassing, entangling system of things, was, at the time we speak of, the seat and instrument of a paganism, and then of heresies, not simply contrary, but bitterly hostile, to the Christian name. Serious men not only had a call, but every inducement which love of life and freedom could inspire, to escape from its presence and its sway.

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[2] Butler, June 22.

[3] Thomassin, Disc. Eccl., t. i., p. 705. Calmet, Reg. Ben., t. ii., p. 25. Mabillon, Acta Sæc., iv., p. 1. præf., p. xxx. Annal., t. i., præf., § 19.

[4] Reg., c. 61.

The principle of monastic unity

Their one idea then, their one purpose, was to be quit of it; too long had it enthralled them. It was not a question of this or that vocation, of the better deed, of the higher state, but of life and death. In other times a variety of holy objects might present themselves for devotion to choose from, such as the care of the poor, or of the sick, or of the young, the redemption of captives, or the conversion of the barbarians; but early monachism was flight from the world, and nothing else. The troubled, jaded, weary heart, the stricken, laden conscience, sought a life free from corruption in its daily work, free from distraction in its daily worship; and it sought employments, as contrary as possible to the world's employments,—employments, the end of which would be in themselves, in which each day, each hour, would have its own completeness;—no elaborate undertakings, no difficult aims, no anxious ventures, no uncertainties to make the heart beat, or the temples throb, no painful combination of efforts, no extended plan of operations, no multiplicity of details, no deep calculations, no sustained machinations, no suspense, no vicissitudes, no moments of crisis or catastrophe;—nor again any subtle investigations, nor perplexities of proof, nor conflicts of rival intellects, to agitate, harass, depress, stimulate, weary, or intoxicate the soul.

was renunciation of the world, of the senses and reason,

Hitherto we have been using negatives to describe what the primitive monk was seeking; in truth monachism was, as regards the secular life and all that it implies, emphatically a negation, or, to use another word, a *mortification;* a mortification of sense, and a mortification of reason. Here a word of explanation is necessary. The monks were too good Catholics to deny that reason was a divine gift, and had too much common sense to think to do without it. What they denied themselves was the various and manifold exercises of the reason; and on this account, because such exercises were excitements. When the reason is cultivated, it at once begins to combine, to centralize, to look forward, to look back, to view things as a whole, whether for speculation or for action; it practises synthesis and analysis, it discovers, it invents. To these exercises of the intellect is opposed simplicity, which is the state of mind which does not combine, does not deal with premisses and conclusions, does not recognize means and their end, but lets each work, each place, each occurrence stand by itself,—which acts towards each as it comes before it, without a thought of anything else. This simplicity is the temper of children, and it is the temper of monks. This was their mortification of the intellect; every man who lives, must live by reason, as every one must live by sense; but, as it is possible to be content with the bare necessities of animal life, so is it possible to confine ourselves to the bare ordinary use of reason, without caring to improve it or make the most of it. These monks held both sense and reason to be the gifts of heaven, but they used each of them as little as they could help, reserving their full time and their whole selves for devotion;—for, if reason is better than sense, so devotion they thought to be better than either; and, as even a heathen might deny himself the innocent indulgences of sense in order to give his time to the cultivation of the reason, so did the monks give up reason, as well as sense, that they might consecrate themselves to divine meditation.

with rest, retirement, simplicity of life.

Now, then, we are able to understand how it was that the monks had a unity, and in what it consisted. It was a unity, we have said, of object, of state, and of occupation. Their object was rest and peace; their state was retirement; their occupation was some work that was simple, as opposed to intellectual, viz., prayer, fasting, meditation, study, transcription, manual labour, and other unexciting, soothing employments. Such was their institution all over the world; they had eschewed the busy mart, the craft of gain, the money-changer's bench, and the merchant's cargo. They had turned their backs upon the wrangling forum, the political assembly, and the pantechnicon of trades. They had had their last dealings with architect and habit-maker, with butcher and cook; all they wanted, all they desired, was the sweet soothing presence of earth, sky, and sea, the hospitable cave, the bright running stream, the easy gifts, which mother earth, "justissima tellus", yields on very little persuasion. "The monastic institute", says the biographer of St. Maurus, "*demands the most perfect quietness*";[5] and where was quietness to be found, if not in reverting to the original condition of man, as far as the changed circumstances of our race admitted, in having no wants, of which the supply was not close at hand; in the "nil admirari"; in having neither hope nor fear of anything below; in daily prayer, daily bread, and daily work, one day being just like another, except that it was one step nearer than the day before it, to that great Day, which would swallow up all days, the day of everlasting rest?

The Summa quies.

M. Guizot's distinction between Eastern and Western monks

However, we have come into collision with a great authority, M. Guizot, and we must stop the course of our argument to make our ground good against him. M. Guizot, then, makes a distinction between monachism in its birth-place, in Egypt and Syria, and that Western institute, of which we have made St. Benedict the representative. He allows that the Orientals mortified the intellect, but he considers that Latin monachism was the seat of considerable mental activity. "The desire for retirement", he says, "for contemplation, for a marked rupture with civilized society, was the source and fundamental trait of the eastern monks: in the West, *on the contrary*, and especially in Southern Gaul, where, at the commencement of the fifth century, the principal monasteries were founded, it was in order to live in common, *with a view to conversation* as well as to religious edification, that the first monks met. The monasteries of Lerins, of St. Victor, and many others, were especially great schools of theology, the focus of intellectual movement. It was by no means with solitude or with mortification, but with discussion and activity, that they there concerned themselves".[6] Great deference is due to an author so learned, so philosophical, so honestly desirous to set out Christianity to the best advantage; yet, we are at a loss to understand what has led him to make such a distinction between the East and West, and to assign to the Western monks an activity of intellect, and to the Eastern a love of retirement.

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[5] Mabillon, Act. Benedict., t. iv., p. 1, p. xxxvii.

untenable;

It is quite true that instances are sometimes to be found of monasteries in the West, distinguished by much intellectual activity, but more, and more striking, instances are to be found of a like phenomenon in the East. If, then, such particular instances are to be taken as fair specimens of the state of Western monachism, they are equally fair specimens of the state of Eastern also; and the Eastern monks will be proved more intellectual than the Western, by virtue of that greater interest in doctrine and in controversy which given individuals or communities among them have exhibited. A very cursory reference to ecclesiastical history will be sufficient to show us, that the fact is as we have stated it. The theological sensitiveness of the monks of Marseilles, Lerins, or Adrumetum, it seems, is to be a proof of the intellectualism generally of the West: then, why is not the greater sensitiveness of the Scythian monks at Constantinople, and of their opponents the Acœmetæ, an evidence in favour of the East? These two bodies of Religious actually came all the way from Constantinople to Rome to denounce one another, besieging, as it were, the Holy See, and the former of them actually attempting to raise the Roman populace against the Pope, in behalf of its own theological tenet. Does not this show activity of mind? We venture to say, that, for one intellectual monk in the West, a dozen might be produced in the East. The very reproach, so freely thrown out by secular historians against the Greeks, of over-subtlety of intellect, applies, if to any men, to certain classes or certain communities of Eastern monks. Some-

not only unfounded,

but contrary to fact,

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[6] History of Civilization, vol. ii., p. 65. Bohn.

times they were enthusiastically orthodox, quite as often furiously heretical. If Pelagius be a monk in the West, on the other hand, Nestorius and Eutyches, both heresiarchs, are both monks in the East; and Eutyches, at the time of his heresy, was an old monk into the bargain, who had been thirty years abbot of a convent, and whom age, if not sanctity, might have saved from this abnormal use of his reason. His partizans were principally monks of Egypt; and they, coming up in force to the pseudo-synod of Ephesus, kicked to death the patriarch of Constantinople, and put to flight the Legate of the Pope, and all this out of a keen susceptibility about an intellectual opinion. A century earlier, Arius, on starting, carried away into his heresy as many as seven hundred nuns;[7] what have the Western convents to show, in the way of controversial activity, comparable with a fact like this? We do not insist on the zealous and influential orthodoxy of the monks of Egypt, Syria, and Asia Minor in the fourth century, because it was probably nothing else but an honourable adhesion to the faith of the Church; but turn to the great writers of Eastern Christendom, and consider how many of them at first sight are monks;—Chrysostom, Basil, Gregory Nazianzen, Epiphanius, Ephrem, Amphilochius, Isidore of Pelusium, Theodore, Theodoret, perhaps Athanasius. Among the Latin writers no names occur to us but those of Jerome and Pope Gregory; we may add Paulinus, Sulpicius, and Cassian, but Jerome is the only learned writer among them. We have a difficulty, then, even in comprehending, not to speak of admitting, M. Guizot's assertion, a writer who does not commonly speak without a meaning or a reason.

as regards Convents,

and as regards Fathers.

But, after all, however the balance of intellectualism may lie between certain convents or individuals in the East and the West, such particular instances are nothing to the purpose, when taken to measure the state of the great body of the monks; certainly not in the West, with which in this paper we are exclusively concerned. In taking an estimate of the Benedictines, we need not trouble ourselves about the state of monachism in Egypt, Syria, Asia Minor, and Constantinople, at least after the fourth century, by the end of which time the tradition had passed from the East to the West. Now, the Eastern Monks of the fourth century simply follow the defined and promul-

Intellectualism of Eastern monks inconsistent with their tradition.

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[7] Epiph. Hær., 69.

gated doctrine of the Church; their intellectualism proper begins with the fifth. Taking, then, the great tradition of St. Antony, St. Pachomius, and St. Basil in the East, and tracing it into the West by the hands of St. Athanasius, St. Martin, and their contemporaries, we shall find no historical facts but what admit of a fair explanation, consistent with the views which we have laid down above about monastic simplicity, bearing in mind always, what holds in all matters of fact, that there never was a rule without its exceptions.

Intellectual and political monks of the West, individual exceptions.

Every rule has its exceptions; but, further than this, when exceptions occur, they are likely to be great ones. This is no paradox; illustrations of it are to be found everywhere. For instance, we may conceive a climate very fatal to children, and yet those who escape growing up to be strong men; and for a plain reason, because those alone could have passed the ordeal who had robust constitutions. Thus the Romans, so jealous of their freedom, when they resolved on the appointment of a supreme ruler for an occasion, did not do the thing by halves, but made him a Dictator. In like manner, a trifling occurrence, or an ordinary inward impulse, will be powerless to snap the bond which keeps the monk fast to his cell, his oratory, and his garden. Exceptions, indeed, may be few, because they *are* exceptions, but they will be great. It must be a serious emergence, a particular inspiration, a sovereign command, which brings the monk into political life; and he will be sure to make a great figure in it, else why should he have been torn from his cloister at all? This will account for the career of St. Gregory the Seventh or of St. Dunstan, of St. Bernard or of Abbot Suger, as far as it was political: the work they had to do was such, as none could have done but a monk with his superhuman single-mindedness and his pertinacity of purpose. Again, in the case of St. Boniface, the Apostle of Germany, and in that of others of the missionaries of his age, it seems to have been a particular inspiration which carried them abroad; and it is observable after all how soon most of them settled down into the mixed character of agriculturists and pastors in their new country, and resumed the tranquil life to which they had originally devoted themselves. As to the early Greek Fathers, some of those whom we have instanced above are only *primá facie* exceptions, as Chrysostom, who, though he lived with the monks most austerely for as many as six years,

And originally in the East also.

can hardly be said to have taken on himself the responsibilities of their condition, or to have simply abandoned the world. Others of them, as Basil, were scholars, philosophers, men of the world, before they were monks, and could not put off their cultivation of mind or their learning with their secular dress; and these would be the very men, in an age when such talents were scarce, who would be taken out of their retirement by superior authority, and who therefore cannot fairly be quoted as ordinary specimens of the monastic life.

As illustrated in St. Basil,

Exceptio probat regulam: let us see what two Doctors of the Church, one Greek, one Latin, both rulers, both monks, say concerning the state, which they at one time enjoyed, and afterwards lost. "You tell me", says St. Basil, writing to a friend from his solitude, "that it was little for me to describe the place of my retirement, unless I mentioned also my habits and my mode of life; yet really I am ashamed to tell you how I pass night and day in this lonely nook. I am like one, who is angry with the size of his vessel, as tossing overmuch, and leaves it for the boat, and is seasick and miserable still. However, what I propose to do is as follows, with the hope of tracing His steps who has said, 'If any one will come after Me, let him deny himself'. We must strive after a quiet mind. As well might the eye ascertain an object which is before it, while it roves up and down without looking steadily at it, as a mind, distracted with a thousand worldly cares, be able clearly to apprehend the truth. One who is not yoked in matrimony, is harassed by rebellious impulses and hopeless attachments; he who is married, is involved in his own tumult of cares: is he without children? he covets them; has he children? he has anxieties about their education. Then there is solicitude about his life, care of his house, oversight of his servants, misfortunes in trade, differences with his neighbours, lawsuits, the merchant's risks, the farmer's toil. Each day, as it comes, darkens the soul in its own way; and night after night takes up the day's anxieties, and cheats us with corresponding dreams. Now, the only way of escaping all this is separation from the whole world, so as to live without city, home, goods, society, possessions, means of life, business, engagements, secular learning, that the heart may be prepared as wax for the impress of divine teaching. Solitude is of the greatest use for this purpose, as it stills our passions, and enables reason to extirpate them. Let then a place be found, such as mine, separate from intercourse with men, that the tenor of our exercises be not interrupted from without. Pious exercises nourish the soul with divine thoughts. Soothing hymns compose the mind to a cheerful and calm state. Quiet, then, as I have said, is the first step in our sanctification; the tongue purified from the gossip of the world, the eyes unexcited by fair colour or comely shape, the ear secured from the relaxation of voluptuous songs, and that especial mischief, light jesting. Thus, the mind, rescued from dissipation from without, and sensible allurements, falls back upon itself, and thence ascends to the contemplation of God".[8] It is quite clear that at least St. Basil took the same view of the monastic state as we have done.

and in St. Gregory, Pope.

So much for the East in the fourth century; now for the West in the seventh. "One day", says St. Gregory, after he had been constrained, against his own wish, to leave his cloister for the government of the Universal Church, "one day, when I was oppressed with the excessive trouble of secular affairs, I sought a retired place, friendly to grief, where whatever displeased me in my occupations might show itself, and all that was wont to inflict pain might be seen at one view". While he was in this retreat, his most dear son, Peter, with whom, since the latter was a youth, he had been intimate, surprised him, and he opened his grief to him. "My sad mind", he said, "labouring under the soreness of its engagements, remembers how it went with me formerly in this monastery, how all perishable things were beneath it, how it rose above all that was transitory, and, though still in the flesh, went out in contemplation beyond that prison, so that it even loved death, which is commonly thought a punishment, as the gate of life and the reward of labour. But now, in consequence of the pastoral charge, it undergoes the busy work of secular men, and for that fair beauty of its quiet, is dishonoured with the dust of the earth. And often dissipating itself in outward things, to serve the many, even when it seeks what is inward, it comes home indeed, but is no longer what it used to be".[9] Here is the very same view of the monastic state at Rome, which St. Basil had in Pontus, viz., retirement and repose. There have been great Religious Orders since, whose atmosphere has been conflict, and who have thriven in smiting or in being smitten. It has been their high calling; it has been their peculiar meritorious service; but, as for the Benedictine, the very air he breathes is peace.

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[8] Ep. 2.

[9] Dial., i. 1.

Monachism aimed at the golden age,

We have now said enough both to explain and to vindicate the biographer of St. Maurus, when he says that the object, and life, and reward of the ancient monachism is "summa quies",—the absence of all excitement, sensible and intellectual, and the vision of Eternity. And therefore have we called the monastic state the most poetical of religious disciplines. It was a return to that primitive age of the world, of which poets have so often sung, the simplicity of Arcadia or the reign of Saturn, when fraud and violence were unknown. It was a bringing back of those real, not fabulous, scenes of innocence and miracle, when Adam delved, or Abel kept sheep, or Noe planted the vine, and Angels visited them. It was a fulfilment in the letter, of the glowing imagery of prophets, about the evangelical period. Nature for art, the wide earth and majestic heavens for the crowded city, the subdued and docile beasts of the field for the wild passions and rivalries of social life, tranquillity for ambition and care, divine meditation for the exploits of the intellect, the Creator for the creature, such was the normal condition of the monk. He had tried the world, and found its hollowness; or he had eluded its fellowship, before it had solicited him;—and so St. Antony fled to the desert, and St. Hilarion sought the sea shore, and St. Basil ascended the mountain ravine, and St. Benedict took refuge in his cave, and St. Giles buried himself in the forest, and St. Martin chose the broad river, in order that the world might be shut out of view, and the soul might be at rest. And such a rest of intellect and of passion as this is full of the elements of the poetical.

and therefore was poetical.

We have no intention of committing ourselves here to a definition of poetry; we may be thought wrong in the use of the term; but, if we explain what we mean by it, no harm is done, whatever be our inaccuracy, and each reader may substitute for it some word he likes better. Poetry, then, we conceive, whatever be its metaphysical essence, or however various may be its kinds, whether it more properly belongs to action or to suffering, nay, whether it is more at home with society or with nature, whether its spirit is seen to best advantage in Homer or in Virgil, at any rate, is always the antagonist to *science*. As science

Poetry as opposed to Science,

makes progress in any subject matter, poetry recedes from it. The two cannot stand together; they belong respectively to two modes of viewing things, which are contradictory of each other. Reason investigates, analyses, numbers, weighs, measures, ascertains, locates, the objects of its contemplation, and thus gains a scientific knowledge of them. Science results in system, which is complex unity; poetry delights in the indefinite and various as contrasted with unity, and in the simple as contrasted with system. The aim of science is to get a hold of things, to grasp them, to handle them, to comprehend them; that is (to use the familiar term), to *master* them, or to be superior to them. Its success lies in being able to draw a line round them, and to tell where each of them is to be found within that circumference, and how each lies relatively to all the rest. Its mission is to destroy ignorance, doubt, surmise, suspense, illusions, fears, deceits, according to the "Felix qui potuit rerum cognoscere causas" of the Poet, whose whole passage, by the way, may be taken as drawing out the contrast between the poetical and the scientific.[10] But as to the poetical, very different is the frame of mind, which is necessary for its perception. It demands, as its primary condition, that we should not put ourselves above the objects in which it resides, but at their feet; that we should feel them to be above and beyond us, that we should look up to them, and that, instead of fancying that we can comprehend them, we should take for granted that we are surrounded and comprehended by them ourselves. It implies that we understand them to be vast, immeasurable, impenetrable, inscrutable, mysterious; so that at best we are only forming conjectures about them, not conclusions, for the phenomena which they present admit of many explanations, and we cannot know the true one. Poetry does not address the reason, but the imagination and affections; it leads to

as Imagination to Reason:

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[10] Me verò primùm dulces ante omnia Musæ . . .
Accipiant, *cœlique vias et sidera monstrent*, etc., etc.
Sin, has ne possim naturæ accedere partes,
Frigidus obstiterit circùm præcordia sanguis,
Rura mihi et rigui placeant in vallibus amnes, etc.

And so again:

Felix, qui potuit rerum cognoscere *causas*, etc.
Fortunatus et ille, Deos qui novit agrestes, etc.

admiration, enthusiasm, devotion, love. The vague, the uncertain, the irregular, the sudden, are among its attributes or sources. Hence it is that a child's mind is so full of poetry, because he knows so little; and an old man of the world so devoid of poetry, because his experience of facts is so wide. Hence it is that nature is commonly more poetical than art, in spite of Lord Byron, because it is less comprehensible and less patient of definitions; history more poetical than philosophy; the savage than the citizen; the knight errant than the brigadier-general; the winding bridle path than the straight railroad; the sailing vessel than the steamer; the ruin than the spruce suburban box; the Turkish robe or Spanish doublet than the French dress coat. We have said far more than enough to make it clear what we mean by that element in the old monastic life, to which we have given the name of the Poetical.

exemplified in the history, and constitution,

Now, in many ways the family of St. Benedict answers to this description, as we shall see if we look into its history. Its spirit indeed is ever one, but not its outward circumstances. It is not an Order proceeding from one mind at a particular date, and appearing all at once in its full perfection, and in its extreme development, and in form one and the same everywhere, and from first to last, as is the case with other great religious institutions; but it is an organization, diverse, complex, and irregular, and variously ramified, rich rather than symmetrical, with many origins and centres and new beginnings and the action of local influences, like some great natural growth; with tokens, on the face of it, of its being a divine work, not the mere creation of human genius. Instead of progressing on plan and system and from the will of a superior, it has shot forth and run out as if spontaneously, and has shaped itself according to events, from an irrepressible fulness of life within, and from the energetic self-action of its parts, like those symbolical creatures in the prophet's vision, which "went every one of them straight forward, whither the impulse of the spirit was to go". It has been poured out over the earth, rather than been sent, with a silent mysterious operation, while men slept, and through the romantic adventures of individuals, which are well nigh without record; and thus it has come down to us, not risen up among us, and is found rather than established. Its separate and scattered monasteries occupy the land, each in its place, with a majesty parallel, but superior, to and the social position of the Benedictines.

that of old aristocratic houses. Their known antiquity, their unknown origin, their long eventful history, their connection with Saints and Doctors when on earth, the legends which hang about them, their rival ancestral honours, their extended sway, perhaps, over other religious houses, their hold upon the associations of the neighbourhood, their traditional friendships and compacts with other great landlords, the benefits they have conferred, the sanctity which they breathe, these and the like attributes make them objects, at once of awe and of affection.

Examples in point.

Such is the great Abbey of Bobio, in the Apennines, where St. Columban came to die, having issued with his twelve monks from his convent in Benchor, county Down, and having spent his life in preaching godliness and planting monasteries in half-heathen France and Burgundy. Such St. Gall's, on the lake of Constance, so called from another Irishman, one of St. Columban's companions, who remained in Switzerland, when his master went on into Italy. Such the Abbey of Fulda, where lies St. Boniface, who, burning with zeal for the conversion of the Germans, attempted them a first time and failed, and then a second time and succeeded, and at length crowned the missionary labours of forty-five years with martyrdom. Such Monte Cassino, the metropolis of the Benedictine name, where the Saint broke the idol, and cut down the grove, of Apollo. Ancient houses such as these subdue the mind by the mingled grandeur and sweetness of their presence. They stand in history with an accumulated interest upon them, which belongs to no other monuments of the past. Whatever there is of venerable authority in other foundations, in Bishops' sees, in Cathedrals, in Colleges, respectively, is found in combination in them. Each gate and cloister has had its own story, and time has engraven upon their walls the chronicle of its revolutions. And, even when at length rudely destroyed, or crumbled into dust, they live in history and antiquarian works, in the pictures and relics which remain of them, and in the traditions of their place.

The particular example of St. Hubert's Abbey.

In the early part of last century the Maurist Fathers, with a view of collecting materials for the celebrated works which they had then on hand, sent two of their number on a tour through France and the adjacent provinces. Among other districts the travellers passed through the forest of Ardennes, which has been made classical by the prose of Cæsar, and the poetry of Shakespeare. There they found the great Benedictine Convent of St. Hubert;[11] and, if we dwell awhile upon the illustration which it affords of what we have been saying, it is not as if twenty other religious houses which they visited would not serve our purpose quite as well, but because it has come first to our hand in turning over the pages of their volume. At that time the venerable abbey in question had upon it the weight of a thousand years, and was eminent above others in the country in wealth, in privileges, in name, and, not the least recommendation, in the sanctity of its members. The lands, on which it was situated, were its freehold, and their range included sixteen villages. The old chronicle informs us, that, about the middle of the seventh century, St. Sigibert, the Merovingian, pitched upon Ardennes and its neighbourhood for the establishment of as many as twelve monasteries, with the hope of thereby obtaining from heaven an heir to his crown. Dying prematurely, he but partially fulfilled his pious intention, which was taken up by Pepin, sixty years afterwards, at the instance of his chaplain, St. Beregise; so far, at least, as to make a commencement of the abbey of which we are speaking. Beregise had been a monk of the Benedictine Abbey of St. Tron, and he chose for its site a spot in the midst of the forest, marked by the ruins of a temple dedicated to the pagan Diana, the goddess of the chase. The holy man exorcised the place with the sign of the Cross; and, becoming abbot of the new house, filled it either with monks, or as seems less likely, with secular canons. From that time to the summer day, when the two Maurists visited it, the sacred foundation, with various fortunes, had been in possession of the land.

Founded in Ardennes

in first years of 8th century,

visited in 18th by Maurists,

On entering its precincts, they found it at once full and empty: empty of the monks, who were in the fields gathering in the harvest; full of pilgrims, who were wont to come day after day, in neverfailing succession, to visit the tomb of St. Hubert. What a series of events has to be recorded to make this simple account intelligible! and how poetical is the picture which it sets before us, as well as those events themselves, which it presupposes, when they come to be detailed! Were it not that we should be

reformed in the 17th

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[11] Voyage Littéraire. Vid. also Calmet, Lorraine, t. i., p. 1043. Moreri, art. S. Hubert. Gallia Christ., t. iii., p. 966. Mabillon, Annal. Bened., t. ii., pp. 16, 441, 606. Bucherii, Gest. Tungr. etc., t. i., p. 153. Helyot, Ordres Mon., t vi., p. 296.

swelling a passing illustration into a history, we might go on to tell how strict the observance of the monks had been for the last hundred years before the travellers arrived there, since Abbot Nicholas de Fanson had effected a reform on the pattern of the French Congregation of St. Vanne. We might relate how, when a simple monk in the Abbey of St. Hubert, Nicholas had wished to change it for a stricter community, and how he got leave to go off to the Congregation just mentioned, and how then his old Abbot died suddenly, and how he himself to his surprise was elected in his place. And we might tell how, when his mitre was on his head, he set about reforming the house which he had been on the point of quitting, and how he introduced for that purpose two monks of St. Vanne; and how the Bishop of Liege, in whose diocese he was, set himself against his holy design, and how some of the old monks attempted to poison him; and how, though he carried it into effect, still he was not allowed to aggregate his Abbey to the Congregation whose reform he had adopted; and how his good example encouraged the neighbouring abbeys to commence a reform in themselves, which issued in an ecclesiastical union of the Flemish Benedictines.

according to the reform of St. Vanne,

All this, however, would not have been more than one passage, of course, in the adventures which had befallen the abbey and its abbots in the course of its history. It had had many seasons of decay before the time of Nicholas de Fanson, and many restorations, and from different quarters. None of them was so famous or important as the reform effected in the year 817, about a century after its original foundation, when the secular canons were put out, and the monks put in, at the instance of the then Bishop of Liege, who had a better spirit than his successor in the time of Nicholas. The new inmates were joined by some persons of noble birth from the Cathedral, and by their suggestion and influence the bold measure was taken of attempting to gain from Liege the body of the great St. Hubert, the Apostle of Ardennes. Great, we may be sure, was the resistance of the city where he lay; but Abbot Alreus, the friend and fellow-workman of St. Benedict of Anian, the first Reformer of the Order before the date of Cluni, went to the Bishop, and he went to the Archbishop of Cologne; and then both prelates went to the Emperor Louis le Debonnaire, the son of Charlemagne, whose favourite hunting ground the forest was; and he referred the matter to the great Council of Aix-la-Chapelle, whence a

reformed in the 9th,

and presented with St. Hubert's body,

decision came in favour of the monks of Ardennes. So with great solemnity the sacred body was conveyed by water to its new destination; and there in the Treasury, in memorial of the happy event, the Maurist visitors saw the very chalice of gold, and the beautiful copy of the Gospels, ornamented with precious stones, given to the Abbey by Louis at the time. Doubtless it was the handiwork of the monks of some other Benedictine House, as must have been the famous Psalter, of which the visitors speak also, written in letters of gold, the gift of Louis's son, the Emperor Lothaire; and there he sits in the first page, with his crown on his head, his sceptre in one hand, his sheathed sword in the other, and something very like a fleur-de-lys buckling on his ermine robe at the shoulder:—which precious gift, that is, the Psalter with all its pictures, two centuries after came most unaccountably into the possession of the Lady Helvidia of Aspurg, who gave it to her young son Bruno, afterwards Pope Leo the Ninth, to learn the Psalms by; but, as the young Saint made no progress in his task, she came to the conclusion that she had no right to the book, and so she ended by making a pilgrimage to St. Hubert with Bruno, and, not only gave back the Psalter, but made the offering of a Sacramentary besides.

and with illuminated MSS.

But to return to the relics of the Saint; the sacred body was taken by water up the Maes. The coffin was of marble, and perhaps could have been taken no other way; but another reason, besides its weight, lay in the indignation of the citizens of Liege, who made several attempts, in the following years, to regain the body. In consequence, the good monks of Ardennes hid it within the walls of their monastery, confiding the secret of its whereabouts to only two of their community at a time; and they showed in the sacristy to the devout, instead, the Saint's ivory cross and his stole, the sole of his shoe and his comb, and Diana, Marchioness of Autrech, gave a golden box to hold the stole. This, however, was in after times; for they were very loth at first to let strangers within their cloisters at all; and in 838, when a long spell of rain was destroying the crops, and the people of the neighbourhood came in procession to the shrine to ask the intercession of the Saint, the cautious Abbot Sewold, availing himself of the Rule, would only admit priests, and them by threes and fours, with naked feet, and a few laymen with each of them. The supplicants were good men, however, and had no

The saint's body concealed,

but visited in devotion.

notion of playing any trick: they came in piety and devotion, and the rain ceased, and the country was the gainer by St. Hubert of Ardennes. And thenceforth others, besides the monks, became interested in his stay in the forest.

Famous for cures of bites.

And now we have said something in explanation, why the courtyard was full of pilgrims, when the travellers came. St. Hubert had been an object of devotion for a particular benefit, perhaps ever since he came there, certainly as early as the eleventh century, for we then have historical notice of it. His preference of the forest to the city, which he had shown in life before his conversion, was illustrated by the particular grace or miraculous service, for which, more than for any other, he used his glorious intercession on high. He is famous for curing those who had suffered from the bite of wild animals, especially dogs of the chase, and a hospital was attached to the Abbey for their reception. The sacristan of the Church officiated in the cure; and with rites which never indeed failed, but which to some cautious persons seemed to savour of superstition. Certainly they were startling at first sight; accordingly a formal charge on that score was at one time brought against them before the Bishop of Liege, and a process followed. The Bishop, the University of Louvain, and its Faculty of Medicine, conducted the inquiry, which was given in favour of the Abbey, on the ground that what looked like a charm might be of the nature of a medical regimen.

Hospital for the patients.

However, though the sacristan was the medium of the cure, the general care of the patients was left to externs. The hospital was served by secular priests, since the monks heard no confessions save those of their own people. This rule they observed, in order to reserve themselves to the proper duties of a Benedictine,—the choir, study, manual labour, and transcription of books; and, while the Maurists were ocular witnesses of their agricultural toils, they saw the diligence of their penmanship in its results, for the MSS. of their Library were the choicest in the country. Among them, they tell us, were copies of St. Jerome's Bible, the Acts of the Councils, Bede's History, Gregory and Isidore, Origen and Augustine.

Library of choice MSS.

Monastic buildings,

The Maurists report as favourably of the monastic buildings themselves, as of the hospital and library. Those buildings were a chronicle of past times, and of the changes which had taken place in them. First there were the poor huts of St. Beregise upon the half-cleared and still marshy ground of the forest; then came the rebuilding, when St. Hubert was brought there; and centuries after that, St. Thierry, the intimate friend of the great Pope Hildebrand, had renewed it magnificently, at the time that he was Abbot. He was sadly treated in his lifetime by his monks, as Nicholas after him; but, after his death, they found out that he was a Saint, which they might have discovered before it; and they placed him in the crypt, and there he and another holy Abbot after him lay in peace, till the Calvinists broke into it in the sixteenth century, and burned both of them to ashes. There were marks too of the same fanatics on the pillars of the nave of the Church; which had been built by Abbot John de Wahart in the twelfth century, and then again from its foundations by Abbots Nicholas de Malaise and Romaclus, the friend of Blosius, four centuries later; and it was ornamented by Abbot Cyprian, who was called the friend of the poor; and doubtless the travellers admired the marble of the choir and sanctuary, and the silver candelabra of the altar given by the reigning Lord Abbot; and perhaps they heard him sing solemn Mass on the Assumption, as was usual on that feast, with his four secular chaplains, one to carry his Cross, another his mitre, a third his gremial, and a fourth his candle, and accompanied by the pealing organ and the many clattering bells, which had been the gift of Abbot Balla about a hundred years earlier. Can we imagine a more graceful union of human with divine, of the sweet with the austere, of business and of calm, of splendour and of simplicity, than is displayed in a great religious house after this pattern, when unrelaxed in its observance, and pursuing the ends for which it was endowed?

Church.

Magnificence of the abbot.

The Monks had been accused of choosing beautiful spots for their dwellings; as if this were a luxury in ascetics, and not rather the necessary alleviation of their penances. Even when their critics are kindest, they consider such sites as chosen by a sort of sentimental, ornamental indolence. "Beaulieu river", says Mr. Warner in his topography of Hampshire, and, as he writes far less illnaturedly than the run of authors, we will quote him, "Beaulieu river is stocked with plenty of fish, and boasts in particular of good oysters and fine plaice, and is fringed quite to the edge of the water with the most beautiful hanging woods. In the area enclosed are distinct traces of various fish-

The monks accused of choosing beautiful spots.

ponds, formed for the use of the convent. Some of them continue perfect to the present day, and abound with fish. A curious instance occurs also of monkish luxury, even in the article of water; to secure a fine spring those monastics have spared neither trouble nor expense. About half a mile to the south-east of the Abbey is a deep wood; and at a spot almost inaccessible is a cave formed of smooth stones. It has a very contracted entrance, but spreads gradually into a little apartment, of seven feet wide, ten deep, and about five high. This covers a copious and transparent spring of water, which, issuing from the mouth of the cave, is lost in a deep dell, and is there received, as I have been informed, by a chain of small stone pipes, which formerly, when perfect, conveyed it quite to the Abbey. It must be confessed, the monks in general displayed an elegant taste in the choice of their situations. Beaulieu Abbey is a striking proof of this. Perhaps few spots in the kingdom could have been pitched upon, better calculated for monastic seclusion than this. The deep woods, with which it is almost environed, throw an air of gloom and solemnity over the scene, well suited to excite religious emotions; while the stream that glides by its side, afforded to the recluse a striking emblem of human life: and at the same time that it soothed his mind by a gentle murmuring, led it to serious thought by its continual and irrevocable lesson".[12]

But they themselves made them beautiful.

The monks were not so soft as all this, after all; and if Mr. Warner had seen them, we feel sure he would have been astonished at the stern, as well as sweet simplicity which characterized them. They were not dreamy sentimentalists, to fall in love with melancholy winds and purling rills, and waterfalls and nodding groves; but their poetry was the poetry of hard work and hard fare, unselfish hearts and charitable hands. They could plough and reap, they could hedge and ditch, they could drain; they could lop, they could carpenter; they could thatch, they could make hurdles for their huts; they could make a road, they could divert or secure the streamlet's bed, they could bridge a torrent. Mr. Warner mentions one of their luxuries,—clear, wholesome water; it was an allowable one, especially as they obtained it by their own patient labour. If their grounds are picturesque, if their views are rich, they made them so, and had, we presume,

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[12] Vol. i., p. 237, etc.

They made a garden in the wilderness,

a right to enjoy the work of their own hands. They found a swamp, a moor, a thicket, a rock, and they made an Eden in the wilderness. They destroyed snakes; they extirpated wild cats, wolves, boars, bears; they put to flight or they converted rovers, outlaws, robbers. The gloom of the forest departed, and the sun, for the first time since the Deluge, shone upon the moist ground. St. Benedict is the true man of Ross.

> Who hung with woods yon mountain's sultry brow?
> From the dry rock who made the waters flow?
> Whose causeway parts the vale with shady rows?
> Whose seats the weary traveller repose?
> He feeds yon almshouse, neat, but void of state,
> When Age and Want sit smiling at the gate;
> Him portioned maids, apprenticed orphans blessed,
> The young who labour, and the old who rest.

as candid Protestants confess.

And candid writers, though not Catholics, allow it. Even English, and much more foreign historians and antiquarians, have arrived at a unanimous verdict here. "We owe the agricultural restoration of great part of Europe to the monks", says Mr. Hallam. "The monks were much the best husbandmen, and the only gardeners", says Forsyth. "None", says Wharton, "ever improved their lands and possessions more than the monks, by building, cultivating, and other methods". The cultivation of Church lands, as Sharon Turner infers from Doomsday Book, was superior to that held by other proprietors, for there was less wood upon them, less common pasture, and more abundant meadow. "Wherever they came", says Mr. Soame on Mosheim, "they converted the wilderness into a cultivated country; they pursued the breeding of cattle and agriculture, laboured with their own hands, drained morasses, and cleared away forests. By them Germany was rendered a fruitful country". M. Guizot speaks as strongly: "The Benedictine monks were the agriculturists of Europe; they cleared it on a large scale, associating agriculture with preaching".[13]

Instances in point

St. Benedict's direct object in setting his monks to manual labour, was neither social usefulness nor poetry, but penance; still his work was both the one and the other. The above cited authors enlarge upon its use, and we may be allowed to dwell upon its poetry; we may contemplate both its utility to man and its service to God in the aspect of its poetry. How romantic then, as well as useful, how lively as well as serious, is their history, with its episodes of personal adventure and prowess, its pictures of squatter, hunter, farmer, civil engineer, and evangelist united in the same individual, its supernatural colouring of heroic virtue and miracle! When St. Columban first came into Burgundy with his twelve young monks, he placed himself in a vast wilderness, and made them set about cultivating the soil. At first they all suffered from hunger, and were compelled to live on the barks of trees and wild herbs. On one occasion they were for five days in this condition. St. Gall, one of them, betook himself to a Swiss forest, fearful from the multitude of wild beasts; and then, choosing the neighbourhood of a mountain stream, he made a cross of twigs, and hung some relics on it, and laid the foundation of his celebrated abbey. St. Ronan came from Ireland to Cornwall, and chose a wood, full of wild beasts, for his hermitage, near the Lizard. The monks of St. Dubritius, the founder of the Welsh Schools, also sought the woods, and there they worked hard at manufactures, agriculture, and road making. St. Sequanus placed himself where "the trees almost touched the clouds". He and his companions, when they first explored it, asked themselves how they could penetrate into it, when they saw a winding footpath, so narrow and full of briars, that it was with difficulty that one foot followed another. With much labour and with torn clothes they succeeded in gaining its depths, and stooping their heads into the darkness at their feet, they perceived a cavern, shrouded by the thick interlacing branches of the trees, and blocked up with stones and underwood. "This", says the monastic account, "was the cavern of robbers, and the resort of evil spirits". Sequanus fell on his knees, prayed, made the sign of the Cross over the abyss, and built his cell there. Such was the first foundation of the celebrated abbey called after him in Burgundy.[14]

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[13] Hallam, Middle Ag., vol. iii., p. 436. Forsyth, Antiqu., vol. i., pp. 37, 44, 179. Turner, Anglo-Sax., vol. ii., p. 167. Murdoch's Mosheim, vol. ii., p. 21, etc. Guizot, Hist. Civil., vol. ii., p. 75, Bohn.

in France,

Switzerland,

England,

Wales,

Sturm, the Bavarian convert of St. Boniface, was

Germany.

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[14] Neander, Memorials, pp. 436, 451, 473, Bohn. Rader, Bavaria Sacra. Calles Ann. Germ., t. i. pp. 200, 276, 317, 318. Guizot, Civil., vol. ii., p. 134. Whitaker's Cornwall, vol. ii., p. 196. Fosbroke, Antiq., p. 16.

seized with a desire, as his master had been in his English monastery, of founding a religious house in the wilds of pagan Germany; and setting out with two companions, he wandered for two days through the Buchonian forest, and saw nothing but earth, sky, and large trees. On the third day he stopped and chose a spot, which on trial did not answer. Then, mounting an ass, he set out by himself, cutting down branches of a night to secure himself from the wild beasts, till at length he came to the place (described by St. Boniface as "locum silvaticum in eremo, vastissimæ solitudinis"), in which afterwards arose the abbey and schools of Fulda. Wunibald was suspicious of the good wine of the Rhine where he was, and, determining to leave it, he bought the land where Heidensheim afterwards stood, then a wilderness of trees and underwood, covering a deep valley and the sides of lofty mountains. There he proceeded, axe in hand, to clear the ground for his religious house, while the savage natives looked on sullenly, jealous for their hunting grounds and sacred trees. Willibald, his brother, had pursued a similar work on system; he had penetrated his forest in every direction and scattered monasteries over it. The Irish Alto pitched himself in a wood, half way between Munich and Vienna. Pirminius chose an island, notorious for its snakes, and there he planted his hermitage and chapel, which at length became the rich and noble abbey and school of Augia Major or Richenau.[15]

Instance of Bec,

The more celebrated School of Bec had a similar beginning at a later date, when Herluin, an old soldier, devoted his house and farm to an ecclesiastical purpose, and governed, as abbot, the monastery which he had founded. "You might see him", says the writer of his life, "when office was over in church, going out to his fields, at the head of his monks, with his bag of seed about his neck, and his rake or hoe in his hand. There he remained with them hard at work till the day was closing. Some were employed in clearing the land of brambles and weeds; others spread manure; others were weeding or sowing; no one ate his bread in idleness. Then when the hour came for saying office in church, they all assembled together punctually. Their ordinary food was bread of bran,[16] and vegetables with salt and water; and the water muddy, for the well was two miles off".[17] Lanfranc, then a secular, was so overcome by the simple Abbot, fresh from the field, setting about his baking with dirty hands, that he forthwith became one of the party;[18] and, being unfitted for labour, opened in the house a school of logic, thereby to make money for the community. Such was the cradle of the scholastic theology; the last years of the patristic, which were nearly contemporaneous, exhibit a similar scene:—St. Bernard founding his abbey of Clairvaux in a place called the Valley of Wormwood, in the heart of a savage forest, the haunt of robbers, and his thirteen companions grubbing up a homestead, raising a few huts, and living on barley or cockle bread with boiled beech leaves for vegetables.[19]

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[15] Meyrick's Willibald, p. 68. Bavaria Sacra, p. 119. Petri, Suevia Eccles., p. 96. Calles Ann. Germ. t. i., p. 191.

of Clairvaux,

of Easterwine at Wearmouth.

How beautiful is Simeon of Durham's account of Easterwine, the first abbot after Bennet of St. Peter's at Wearmouth! He was a man of noble birth, who gave himself to religion, and died young. "Though he had been in the service of King Egfrid", says Simeon, "when he had once left secular affairs, and laid aside his arms, and taken on him the spiritual warfare instead, he was nothing but the humble monk, just like any of his brethren, winnowing with them with great joy, milking the ewes and cows, and in the bakehouse, the garden, the kitchen, and all house duties, cheerful and obedient. And, when he received the name of Abbot, still he was in spirit just what he was before to every one, gentle, affable, and kind; or, if any fault had been committed, correcting it indeed by the Rule, but still so winning the offender by his unaffected earnest manner, that he had no wish ever to repeat the offence, or to dim the brightness of that most clear countenance with the cloud of his transgression. And often going here and there on business of the monastery, when he found his brothers at work, he would at once take part in it, guiding the plough, or shaping the iron, or taking the winnowing fan, or the like. He was young and strong, with a sweet voice, a cheerful temper, a liberal heart, and a handsome countenance. He partook of the same food as his brethren, and under the same roof. He slept in the common dormitory, as before he was abbot, and he continued to do so for the first two days of his illness, when death had now seized him, as he knew full well. But for the last five days he betook himself to a more retired dwelling; and then, coming out into the open air and sitting down, and calling for all his brethren, after the manner of his tender nature, he gave his weeping monks the kiss of peace, and died at night while they were singing lauds".[20]

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[16] Siligineus, i. e. *wheaten;* but can it be quasi ex siliquâ, not, ex siligine? *vid.* Hor. Ep. lib. 2, 123.

[17] Butler's Lives, Aug. 20.

[18] Apud. Mabillon Act. Bened.

[19] Thomass. Disc. Eccl. t. iii. p. 513.

Amiableness of the monastic character.

This gentleness and tenderness of heart seems to have been as characteristic of the monks as their simplicity; and if there are some Saints among them, who on the public stage of history do not show it, it was because they were called out of their convents for some special purpose. Bede goes out of his way to observe of Ethelbert, on St. Austin's converting him, that "he had learned from the teachers and authors of his salvation, that men were to be drawn heavenwards, and not forced". Aldhelm, when a council had been held about the perverse opinions of the British Christians, seconding the principle which the Fathers of it laid down, that "schismatics were to be convinced, not compelled", wrote a book upon their error and converted many of them. Wolstan, when the civil power failed in its attempts to stop the slave trade of the Bristol people, succeeded by his persevering preaching. In the confessional he was so gentle, that penitents came to him from all parts of England.[21] This has been the spirit of the monks from the first; the student of ecclesiastical history may recollect a certain passage in St. Martin's history, when his desire to shield the Spanish heretics from death brought him into difficulties, from which he hardly escaped, in his mode of dealing with the usurper Maximus.

Penance subservient to almsgiving.

Penance indeed and mercy have gone hand in hand in the history of the monks; from the Solitaries in Egypt down to the Trappists of this day, it is one of the points in which the unity of the monastic idea shows itself. They have ever toiled for others, while they toiled for themselves; nor for posterity only, but for their poor neighbours, and for travellers who came to them. St. Augustine tells us, that the monks of Egypt and of the East made so much by manual labour as to be able to freight vessels with provisions for impoverished districts.

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[20] P. 93. The passage seems taken from Bede.

[21] Bede, Hist. Eccles., i. 26. William of Malmesb. Ponfic. Angl.

Theodoret speaks of a certain five thousand of them, who by their labour supported, besides themselves, innumerable poor and strangers. Sozomen speaks of the monk Zeno, who, though a hundred years old, and the bishop of a rich Church, worked for the poor as well as for himself. Corbinian in a subsequent century surrounded his German Church with fruit trees and vines, and sustained the poor with the produce. The monks of St. Gall, already mentioned, gardened, planted, fished, and thus secured the means of relieving the poor and entertaining strangers. "Monasteries", says Neander, "were seats for the promotion of various trades, arts, and sciences. The gains accruing from their combined labour were employed for the relief of the distressed. In great famines, thousands were rescued from starvation".[22] In a scarcity at the beginning of the twelfth century, a monastery in the neighbourhood of Cologne distributed in one day fifteen hundred alms, consisting of bread, meat, and vegetables. About the same time, St. Bernard founded his monastery of Citeaux, which, though situated in the waste district described above, was able at length to sustain two thousand poor for months, besides extraordinary alms bestowed on others. The monks offered their simple hospitality, uninviting as it might be, to high as well as low; and to those who scorned their fare, they at least could offer a refuge in misfortune or danger, or after casualties.

Instances in point.

Abbey of Jumieges.

Duke William, ancestor of the Conqueror, was hunting in the woods about Jumieges, when he fell in with a rude hermitage.[23] Two monks had made their way through the forest, and with immense labour had rooted up some trees, levelled the ground, raised some crops, and put together their hut. William heard their story, not perhaps in the best humour, and flung aside in contempt the barley bread and water which they offered him. Presently he was brought back wounded and insensible: he had got the worst in an encounter with a boar. On coming to himself, he accepted the hospitality which he had refused at first, and built for them a monastery. Doubtless he had looked on them as trespassers or squatters on his domain, though with a religious character and object. The Norman princes were as good friends to the wild beasts as the monks were enemies: a charter still exists of the Conqueror granted to the abbey of Caen,[24] in which he stipulates that its inmates should not turn the woods into tillage, and reserves the game for himself.

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[22] Eccl. Hist., vol. vii., p. 331, Bohn.
[23] Duchesne, Script. North., p. 236.

Monastery of Subiaco.

Contrast with this savage retreat and its rude hospitality, the different, though equally Benedictine picture of the sacred grove of Subiaco, and the spiritual entertainment which it ministers to all comers, as given in the late pilgrimage of Bishop Ullathorne: "The trees", he says, "which form the venerable grove, are very old, but their old age is vigorous and healthy. Their great gray roots expose themselves to view with all manner of curling lines and wrinkles on them, and the rough stems bend and twine about with the vigour and ease of gigantic pythons. . . . Of how many holy solitaries have these trees witnessed the meditations! And then they have seen beneath their quiet boughs the irruption of mailed men, tormented by the thirst of plunder and the passion of blood, which even a sanctuary held so sacred could not stay. And then they have witnessed, for twelve centuries and more, the greatest of the Popes, the Gregories, the Leos, the Innocents, and the Piuses, coming one after another to refresh themselves from their labours in a solitude which is steeped with the inspirations and redolent with the holiness of St. Benedict.[25]

Benedictine life a fit subject for Virgil.

What congenial subjects for his verse would the sweetest of all poets have found in scenes and histories such as the foregoing, he who in his Georgics has shown such love of a country life and country occupations, and of the themes and trains of thought which rise out of the country! Would that Christianity had a Virgil to describe the old monks at their rural labours, as it has had a Sacchi or a Domenichino to paint them! How would he have been able to set forth the adventures and the hardships of the missionary husbandmen, who sang of the Scythian winter, and the murrain of the cattle, the stag of Sylvia, and the forest home of Evander! How could he have pourtrayed St. Paulinus or St. Serenus in his garden, who could draw so beautiful a picture of the old Corycian, raising amid the thicket his scanty potherbs upon the nook of land, which was "not good for tillage, nor for pasture, nor for vines"! How could he have brought out the poetry of those simple labourers, who has told us of that old man's flowers and fruits, and of the satisfaction, as a king's, which he felt in those innocent riches! He who had so huge a dislike of cities, and great houses, and high society, and sumptuous banquets, and the canvass for office, and the hard law, and the noisy lawyer, and the statesman's harangue,—he who thought the country proprietor as even too blessed, did he but know his blessedness, and who loved the valley, winding stream, and wood, and the hidden life which they offer, and the deep lessons which they whisper,—how could he have illustrated that wonderful union of prayer, penance, toil, and literary work, the true "otium cum dignitate", a fruitful leisure and a meek-hearted dignity, which is exemplified in the Benedictine! That ethereal fire which enabled the prince of Latin poets to take up the Sibyl's strain, and to adumbrate the glories of a supernatural future, that serene philosophy, which has strewn his poems with sentiments which come home to the heart, that intimate sympathy with the sorrows of human kind and with the action and passion of human nature, how well would they have served to illustrate the patriarchal history and office of the monks in the broad German countries, or the deeds, the words, and the visions of a St. Odilo or a St. Aelred!

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[24] Turner, Middle Ag., vol. v., p. 89.

[25] P. 37.

from his love of rural labours,

of communion with nature,

of philosophic meditation;

What a poet deliberately chooses for the subject of his poems, must be in its own nature poetical. A poet indeed is but a man after all, and in his proper person may prefer solid beef and pudding to all the creations of his own "fine frenzy", which, in his character of poet, are his meat and drink. But no poet will ever commit his poetical reputation to the treatment of subjects which do not admit of poetry. When, then, Virgil chooses the country and rejects the town, he shows us that a certain aspect of the town is uncongenial with poetry, and that a certain aspect of the country is congenial. Repose, intellectual and moral, is that quality of country life which he selects for his praises; and effort, and bustle, and excitement is that quality of a town life which he abhors. Herein then, according to Virgil, lies the poetry of St. Benedict, in the "secura quies et nescia fallere vita", in the absence of anxiety and fretfulness, of schemes and scheming, of hopes and fears, of doubts and disappointments. Such a life,—living for the day without solicitude for the morrow, without plans or objects, even holy ones, here below; working, not (so to say) by the piece, but as hired by the hour; sowing the ground with the certainty, according to the promise, of reaping; reading

and therefore poetical.

or writing this present week without the consequent necessity of reading or writing during the next; dwelling among one's own people without distant ties; taking each new day as a whole in itself, an addition, not a complement, to the past; and doing works which cannot be cut short, for they are complete in every portion of them,—such a life may be called emphatically Virgilian. They, on the contrary, whose duty lies in what may be called *undertakings*, in science and system, in sustained efforts of the intellect or elaborate processes of action,—apologists, controversialists, disputants in the schools, professors in the chair, teachers in the pulpit, rulers in the Church,—have a noble and meritorious mission, but not so poetical a one. When the bodily frame receives an injury, or is seized with some sudden malady, nature may be expected to set right the evil, if left to itself, but she requires time; science comes in to shorten the process, and is violent that it may be certain. This may be taken to illustrate St. Benedict's mode of counteracting the miseries of life. He found the world, physical and social, in ruins, and his mission was to restore it in the way, not of science, but of nature, not as if setting about to do it, not professing to do it by any set time or by any rare specific or by any series of strokes, but so quietly, patiently, gradually, that often, till the work was done, it was not known to be doing. It was a restoration, rather than a visitation, correction, or conversion. The new world which he helped to create was a growth rather than a structure. Silent men were observed about the country, or discovered in the forest, digging, clearing, and building; and other silent men, not seen, were sitting in the cold cloister, tiring their eyes, and keeping their attention on the stretch, while they painfully deciphered and copied and re-copied the manuscripts which they had saved. There was no one that "contended, or cried out", or drew attention to what was going on; but by degrees the woody swamp became a hermitage, a religious house, a farm, an abbey, a village, a seminary, a school of learning, and a city. Roads and bridges connected it with other abbeys and cities, which had similarly grown up; and what the haughty Alaric or fierce Attila had broken to pieces, these patient meditative men had brought together and made to live again.

results of Benedictines

resemble nature, not art,

a growth not a work.

And then, when they had in the course of many years gained their peaceful victories, perhaps some new invader came, and with fire and sword undid their slow and persevering toil in an hour. The Hun succeeded to the Goth, the Lombard to the Hun, the Tartar to the Lombard; the Saxon was reclaimed only that the Dane might take his place. Down in the dust lay the labour and civilization of centuries,—Churches, Colleges, Cloisters, Libraries,—and nothing was left to them but to begin all over again; but this they did without grudging, so promptly, cheerfully, and tranquilly, as if it were by some law of nature that the restoration came, and they were like the flowers and shrubs and fruit trees which they reared, and which, when ill-treated, do not take vengeance, or remember evil, but give forth fresh branches, leaves, or blossoms, perhaps in greater profusion, or with richer quality, for the very reason that the old were rudely broken off. If one holy place was desecrated, the monks pitched upon another, and by this time there were rich or powerful men who remembered and loved the past enough, to wish to have it restored in the future. Thus was it in the case of the monastery of Ramsey after the ravages of the Danes. A wealthy Earl, whose heart was touched, consulted his Bishop how he could best promote the divine glory: the Bishop answered that they only were free, serene, and unsolicitous, who renounced the world, and that their renunciation brought a blessing on their country. "By their merit", he said, "the anger of the Supreme Judge is abated; a healthier atmosphere is granted; corn springs up more abundantly; famine and pestilence withdraw; the state is better governed; prisons are opened; the fetters unbound; the shipwrecked relieved". He proceeded to advise him, as the best of courses, to give ground for a monastery, and to build and endow it. Earl Alwin observed in reply, that he had inherited some waste land in the midst of marshes, with a forest in the neighbourhood, some open spots of good turf, and others of meadow; and he took the Bishop to see it. It was in fact an island in the fens, and as lonely as religious men could desire. The gift was accepted, workmen were collected, the pious peasants round about gave their labour. Twelve monks were found from another cloister; cells and a chapel were soon raised. Materials were collected for a handsome church; stones and cement were given; a firm foundation was secured; scaffolding and machinery were lent; and in course of time a sacred edifice and two towers rose over the desolate waste, and renewed the past;—a

Their patience in restoring what was destroyed,

like that of nature.

Instance of Abbey of Ramsey.

learned divine from France was invited to preside over the monastic schools.[26]

Their literary labours

Here then we are led lastly to speak of the literary labours of the Benedictines, but we have not room to do more than direct attention to the peculiar character of their work, and must pass over their schools altogether. Here, as in other respects above noticed, the unity of monachism shows itself. What the Benedictines have been, even in their latest literary developments, in St. Maur in the seventeenth century, and at Solesme now, such were the monks in their first years. One of the chief occupations of the disciples of St. Pachomius in Egypt, was the transcription of books. It was the sole labour of the monks of St. Martin in Gaul. The Syrian solitaries, according to St. Chrysostom, employed themselves in making copies of the Holy Scriptures. It was the occupation of the monks of St. Equitius and of Cassiodorus, and of the nunnery of St. Cæsarius. We read of one holy man preparing the skins for writing, of another selling his manuscripts in order to gain alms for the poor, and of an abbess writing St. Peter's Epistles in letters of gold. St. David had shown the same reverence to St. John's Gospel. Abbot Plato filled his own and other monasteries with his beautifully written volumes.[27] During the short rule of Abbot Desiderius at Monte Cassino, his monks wrote out St. Austin's fifty Homilies, his Letters, his Comment upon the Sermon on the Mount, upon St. Paul and upon Genesis; parts of St. Jerome and St. Ambrose, part of St. Bede, St. Leo's Sermons, the Orations of St. Gregory Nazianzen; the Acts of the Apostles, the Epistles and the Apocalypse; various histories, including that of St. Gregory of Tours, Josephus on the Jewish War, Justinian's Institutes, and many ascetic and other works; of the Classics, Cicero de Naturâ Deorum, Terence, Ovid's Fasti, Horace, and Virgil. Maurus Lapi, a Camaldolese, in the fifteenth century, copied a thousand volumes in less than fifty years. Jerome, a monk in an Austrian monastery, wrote so great a number of books, that, it is said, a wagon with six horses would scarcely suffice to draw them. Othlon, in the eleventh century, when a boy, wrote so diligently,

combined with alms-giving.

Transcription of MSS. in point.

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[26] *Vide* Turner, Anglo-Saxons, vol. iii., p. 468.

[27] Pallad, c. 39. Cassian, Inst., iv., 12. Calmet, Reg., t. ii., p. 150. Thomassin, Disc. Eccl., t. iii., p. 505. Ziegelbaum, Hist. Litt. Bened., t. ii., p. 510.

that he nearly lost his sight. That was in France; he then went to Ratisbon, where he wrote nineteen missals, three books of the Gospel, two books of Epistle and Gospel, and many others. Many he gave to his friends, but the list is too long to finish. The Abbot Odo of Tournay "used to exult", according to his successor, "in the number of writers which the Lord had given him. Had you gone into his cloister, you might have seen a dozen young men sitting in perfect silence, writing at tables, constructed for the purpose. All Jerome's Commentaries on the Prophets, all the works of St. Gregory, all that he could find of Austin, Ambrose, Isidore, Bede, and the Lord Anselm, Abbot of Bec, and afterwards Archbishop of Canterbury, he caused to be diligently transcribed".[28]

Calligraphy, illumination, decoration.

These tranquil labourers found a further field in the illumination and binding of the transcribed volumes, as they had previously been occupied in the practice necessary for the then important art of calligraphy. It was not running hand that the monks had to learn; for it was no ephemeral expression of their own thoughts, which their writing was to convey, but the formal transcript, for the benefit of posterity, of the words of inspired teachers and Doctors of the Church. They were performing what has been since the printer's work; and it is said that from the English monks is derived the small letter of the modern Roman type. In France the abbeys of Fontenelle, Rheims, and Corbie were especially famed for beauty of penmanship in the age of Charlemagne,[29] when literature was in its most depressed state. Books intended for presents, such as that which the mother of Leo the Ninth presented to St. Hubert, and, much more, if intended for sacred uses, were enriched with gold and silver plates and precious stones. Here was a commencement of the cultivation of the fine arts in those turbulent times,—a quiet, unexciting occupation, which went on inside the monasteries, whatever rivalries or heresies agitated Christendom outside of them, and which, though involving, of course, an improvement in the workmanship as time went on, yet in the case of every successive spe-

Instances.

The fine arts.

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[28] Annal. Camald., t. vii., p. 300: *vid.* other instances in Maitland's Dark Ages, and Buckingham's Bible in the Middle Ages, who is deficient in references.

[29] Guizot's Hist. Civil, vol. ii., p. 236, Bohn.

cimen, whatever exact degree of skill or taste each exhibited, had its end in itself, as though there had been no other specimen before or after.

Instance of Fulda. Brower, in his work on the Antiquities of Fulda, gives us a lively picture of the various tranquil occupations, which were going on at one time within the monastic walls. "As industrious bees", he says, "their work never flagging, did these monks follow out their calling. Some of them were engaged in describing, here and there upon the parchment, the special letters and characters which were to be filled in; others were wrapping or binding the manuscripts in handsome covers; others were marking out in red the remarkable sentences or the heads of the chapters. Some were writing fairly what had been thrown together at random, or had been left out in the dictation, and were putting every part in fair order. And not a few of them excelled in painting in all manner of colours, and in drawing figures".[30] He goes on to refer to an old manuscript there which speaks of the monks as decorating their church, and of their carpenters' work, sculpture, engraving, and brass work.

Goldsmiths' work.

St. Dunstan. We have mentioned St. Dunstan in an earlier page, as called to political duties, which were out of keeping with the traditionary spirit of his Order; here, however, he shows himself in the simple character of a Benedictine. He had a taste for the arts generally, especially music. He painted and embroidered; his skill in smith's work is recorded in the well-known legend of his combat with the evil one. And, as the monks of Hilarion joined gardening with psalmody, and Bernard and his Cistercians joined field work with meditation, so did St. Dunstan use music and painting as directly expressive or suggestive of devotion. "He excelled in writing, painting, moulding in wax, carving in wood and bone, and in work in gold, silver, iron, and brass", says the writer of his life in Surius. "And he used his skill in musical instruments, to charm away himself and others from secular annoyances, and to rouse them to the thought of heavenly harmony, both by the sweet words with which he accompanied his airs, and by the concord of those airs themselves".[31] And then he goes on to mention, how on one occasion, when

Music.

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[30] P. 45.

[31] *Vid.* also Whitaker's Cornwall, vol. i., p. 167, and the whole chapter.

he had hung his harp against the wall, and the wind brought out from its strings a wild melody, he recognized in it one of the antiphons in the Commune Martyrum, "Gaudete in Cœlis", etc., and used it for his own humiliation.

Mosaic, inlaying, etc.

As might be expected, the monasteries of the South of Europe would not be behind the North in accomplishments of this kind. Those of St. Gall, Monte Cassino, and Solignac, are especially spoken of as skilled in the fine arts. Monte Cassino excelled in *miniatura* and mosaic, the Camaldolese in painting, and the Olivetans in wood-inlaying.[32]

Their study of Scripture and the Fathers.

While manual labour, applied to these artistic purposes, ministered to devotion, on the other hand, when applied to the transcription and multiplication of books, it was a method of instruction, and that peculiarly Benedictine, as being of a literary, not a scientific nature. Systematic theology had but a limited place in ecclesiastical study prior to the eleventh and twelfth centuries; Scripture and the Fathers were the received means of education, and these constituted the very text on which the pens of the monks were employed. And thus they would be becoming familiar with that kind of knowledge which was proper to their vocation, at the same time that they were engaged in what was unequivocally a manual labour; and, in providing for the religious necessities of posterity, they were directly serving their own edification. And this again had been the practice of the monks from the first, and is included in the *unity* of their profession. St. Chrysostom tells us that their ordinary occupation in his time was "to sing and pray, to read Scripture, and to transcribe the sacred text".[32] As the writings of the Fathers gradually became the literary property of the Church, these, too, became the subject matter of the reading and the writing of the monks. "For him who is going on to perfection", says St. Benedict in his Rule, "there are the lessons of the Holy Fathers, which lead to its very summit. For what page, what passage of the Old or New Testament, coming as it does with divine authority, is not the very exactest rule of life? What book of the Holy Catholic Fathers does not resound with this one theme, how we may take the shortest course to our Creator?" But we need not here insist on this characteristic of monastic study, which, especially as regards the study of Scripture, has been treated so fully and so well by Mr. Maitland in his "Essays on the Dark Ages".

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[32] Meehan's Marchese, p. xxiv.

[33] Hist. Liter. de St. Maur, 1770, p. 21.

Their Catenæ and Summæ.

The sacred literature of the monks went a step further. They would be naturally led by their continual perusal of the Scriptures and the Fathers, to attempt to compare and adjust these two chief sources of theological truth with each other. Hence resulted the peculiar character of the religious works of what may be especially called the Benedictine period, the five centuries between St. Gregory and St. Anselm. The age of the fathers was well nigh over; the age of the schoolmen was yet to come; the ecclesiastical writers of the intervening period employed themselves for the most part in arranging and digesting the patristical literature which had come down to them; they either strung together choice passages of the Fathers in *catenæ*, as a running illustration of the inspired text, or they formed them into a comment upon it. The *Summæ Sententiarum* of the same period were works of a similar character, while they also opened the way to the intellectual exercises of the scholastic period; for they were lessons or instructions arranged according to a scheme or system of doctrine, though they were still extracted from the works of the Fathers, and though the matter of those works suggested the divisions or details of the system. Moreover, such labours, as much as transcription itself, were Benedictine in their spirit, as well as in their subject matter; for where there was nothing of original research, nothing of brilliant or imposing result, there would be nothing to dissipate, elate, or absorb the mind, or to violate the simplicity and tranquillity proper to the monastic state.

Their annals and chronicles,

The same remark applies to a further literary employment in which the Benedictines allowed themselves, and which is the last we shall here mention, and that is the compilation of chronicles and annals, whether ecclesiastical, secular, or monastic. So prominent a place does this take in their literature, that the author of the *Asceticon*, in the fourth volume of Dom Francois's Bibliotheque des Ecrivains Bénédictins, does not hesitate to point to the historical writings of his Order as constituting one of its chief claims, after its Biblical works, on the gratitude of posterity. "This", he says, "is the praise especially due to the monks, that they have illustrated Holy Scripture, rescued history, sacred and profane, from the barbarism of the times, and have handed down to posterity so many lives both of Saints and of Bishops".[34] Here again is a fresh illustration of the Benedictine character; for first, those histories are of the most simple structure and most artless composition, and next, from the circumstance of their being commonly narratives of contemporary events, or compilations from a few definite sources of information which were at hand, they involved nothing of that laborious research and excitement of mind which is demanded of the writer who has to record a complex course of history, extending over many centuries and countries, and who aims at the discovery of truth, in the midst of deficient, redundant, or conflicting testimony. "The men who wrote history", says Mr. Dowling, speaking of the times in question, "did not write by rule; they only put down what they had seen, what they had heard, what they knew. Very many of them did what they did as a matter of moral duty. The result was something *sui generis;* it was not even what *we* call history at all. It was, if I may so speak, something more, an actual admeasurement rather than a picture; or, if a picture, it was painted in a style, which had all the minute accuracy and homely reality of the most domestic of the Flemish masters, not the lofty hyperbole of the Roman school, nor the obtrusive splendour, not less unnatural, of the Venetian. In a word, history, as a subject of criticism, is an art, a noble and beautiful *art;* the historical writings of the middle ages is *nature*".[35]

not philosophic histories,

Allusion is made in this passage to the peculiarity in monastic historiography, that it proceeded from the motive of religious obedience. This must always have been the case from the monastic profession; however, we have here, in addition to the presumption, actual evidence, and not on one occasion only, of the importance which the Benedictine Order attached to these notices and memorials of past times. In the year 1082, for instance, the Abbot Marquand of New Corbie in Saxony seems to have sent an order to all churches and monasteries subject to his rule, to send to him severally the chronicles of their own places. Abbot Wichbold repeated the order sixty years later, and Abbot Thierry in 1337 addressed to the provosts and rectors subject to him, a like injunction.[36] Again,

much insisted on.

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[34] P. 379. Printing, another tranquil work, was introduced into Italy by the Benedictines of Subiaco. *Vid.* Dr. Ullathorne's Pilgrimage.

[35] Introd. Eccles. Hist., p. 56.

[36] Ziegelbaur, t. ii., p. 401.

in 1481 the Abbot of Erfurdt addressed a letter to the Fathers of the Reform of Bursfeld, with the view of persuading them to enter into a similar undertaking. "If you were to agree among yourselves", he says, "and make a statute to the effect that every Prelate is under an obligation to compose annals and histories of his monastery, what could be better, what more useful, what more interesting, whether for knowing or for reading?"[37]

What place literature had in their employments.

It is easier to conjecture what those literary works would be, in which a Benedictine would find himself at liberty to engage, than to pretend to point out those from which his vocation would debar him; yet Mabillon, equally with de Rancé, implied that all subjects do not come alike to him. Here we are recalled to the well known controversy between these two celebrated men. The Abbot of La Trappe, the Cistercian de Rancé, writing to his own people, put forth some statements on the subject of the studies proper to a monk, which seemed to reflect upon the learned Maurists. Mabillon, one of them, replied, in a learned vindication of himself and his brethren. The Abbot had maintained that study of whatever kind should be kept in strict subordination to manual labour, and should not extend to any books except the Scriptures and the ascetic treatises of the Fathers. Mabillon, on the other hand, without denying the necessity of manual labour, to which the Maurists themselves devoted an hour a day, seemed to allow to the Benedictine the free cultivation of the intellect, and an unlimited range of studies. When they explained themselves, each combatant would appear to have asserted more than he could successfully maintain; yet after all there was a considerable difference of view between them, which could not be removed. The critical question was, whether certain historical instances, which Mabillon urged in his favour, were to be considered exceptions or not to the rule of St. Benedict. For ourselves, we have certainly maintained in an earlier page of this article, that such instances as Alcuin, Paschasius, or Lanfranc are no fair specimens of the Benedictine profession, and must not be taken to represent the monks generally. Lest, however, in saying this, we may be thought to be evading the testimony of history, as adduced by a writer, authoritative at once by his learning and as spokes-

Controversy on the subject between de Rancé and Mabillon.

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[37] *Ibid.*, t. i., p. 424. For lists of monastic histories, *vide* Mr. Dowling, as above,p. 260; the Asceticon as above, § 26. Ziegelbaur, t. ii., p. 398. Balmez., Prot. and Cath., p. 195.

man of the great Congregation of St. Maur, we think it well to extract in our behalf some of his own admissions, which seem to us fully to bear out what we were laying down above about the spirit and mission of his Order.

Concessions of Mabillon.

For instance, he frankly concedes, or rather maintains, that the scholastic method of teaching theology and philosophy is foreign to the profession of a Benedictine, as such. "Why", he asks, "need we cultivate these sciences in the way of disputation? Why not as positive sciences, explaining questions and resolving doubts, as they occur? Why is it not more than enough for religious pupils to be instructed in the more necessary principles of the science, and thereby to make progress in the study of the Scriptures and the Fathers? What need of this perpetual syllogizing in form, and sharp answers to innumerable objections, as is the custom in the schools?" Elsewhere, he contrasts the mode of teaching a subject, as adopted by the early Fathers, with that which the schoolmen introduced. "The reasonings of the Fathers", he says, "are so full, so elegantly set forth, as to be everywhere redolent of the sweetness and vigour of Christian eloquence, whereas scholastic theology is absolutely dry and sterile". Elsewhere he says, that "in the study of Holy Scripture consists the entire science of monks". Again, he says of Moral Theology, "As monks are rarely destined to the cure of souls, it does not seem necessary that they should give much time to the science of Morals". And, though of course he does not forbid them the study of history, which we have seen to be so congenial to their calling, yet he observes of this study when pursued to its full extent, "It seems to cause much dissipation of mind, which is prejudicial to that inward compunction of heart, which is so especially fitting to the holy life of a monk". Again, observing that the examination of ancient MSS. was the special occupation of the Maurists in his time, he says, "They who give themselves to this study have the more merit with God, in that they have so little praise with men. Moreover, it obliges them to devote the more time to solitude, which ought to be their chief delight. I confess it is a most irksome and unpleasant labour; however, it gives much less trouble than transcription, which was the most useful work of our early monks". Elsewhere, speaking of the celebrated Maurist editions of the Fathers, he observes, "Labour, such as this, which is undergone in silence and in quietness, is especially

He gives up disputation,

moral theology.

general history.

Insists on investigation of MSS.,

and editions of the Fathers.

compatible with true tranquillity of mind, and the mastery of the passions, provided we labour as a duty, and not for glory".[38]

On the whole, what literature not Benedictine,

We trust the reader will be so good as to keep in mind that we are all along speaking of the Benedictine life *historically*, and as we might speak of any other historical *fact;* not venturing at all on what would be the extreme presumption of any quasi-doctrinal or magisterial exposition of it, which belongs to those only who have actually imbibed its tradition. This being clearly understood, we think we may interpret Mabillon to mean that (be the range of studies lawful to a monk what it may) still, whatever literary work requires such continuous portions of time as not to admit of being suspended at a moment's notice, whatever is so interesting that other duties seem dull and heavy after it, whatever so exhausts the power of attention as to incapacitate for attention for other subjects, whatever makes the mind gravitate towards the creature, is inconsistent with monastic simplicity. Accordingly, we should expect to find that controversy was uncongenial to the Benedictine, because it excited the mind, and metaphysical investigations, because they fatigued it; and, when we met such instances as St. Paschasius or St. Anselm, we should deal with them as they came and as we could. Moreover, we should not look to a Benedictine for any elaborate and systematic work on the history of doctrine, or of heresy, or any course of patristical theology, or any extended ecclesiastical history, or any philosophical disquisitions upon history, as implying a grasp of innumerable details, and the labour of using a mass of phenomena to the elucidation of a theory, or of bringing a range of multifarious reading to bear upon one point; and that, because such efforts of mind require either an energetic memory devoted to matters of time and place, or, instead of the tranquil and plodding study of one book after another, the presence of a large library, and the distraction of a vast number of books handled all at once, not for perusal, but for reference. Perhaps we are open to the charge of refining, in attempting to illustrate the principle which we seem to ourselves to detect in the Benedictine tradition; but the principle itself which we have before us is clear enough, and is expressed in the advice which is given to

not polemical, nor metaphysical, nor systematic.

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[38] Stud. Monast., ed. 1732; t. i., pp. 52, 135; t. ii p. 2; t. i., pp. 145, 147, 191, 64.

us by a sacred writer: "The words of the wise are as goads, and nails deeply fastened in; *more than these, my son, require not:* of making many books there is no end, and much study is an affliction of the flesh".

Contrasted with that of French Oratorians, of Jesuits, as being Biblical, patristical, antiquarian, and documentary.

To test the truth of this view of the Benedictine mission, we cannot do better than appeal as a palmary instance to the Congregation of St. Maur, an intellectual school of Benedictines assuredly. Now what, in matter of fact, is the character of its works? It has no Malebranche, no Thomassin, no Morinus; it has no Bellarmine, no Suarez, no Petavius; it has no Tillemont or Fleury,—all of whom were more or less its contemporaries; but it has a Montfaucon, it has a Mabillon, it has a Sainte Marthe, a Coustant, a Sabbatier, a Martene,—men of immense learning and research; it has collators and publishers of MSS. and of inscriptions, editors of the text and of the versions of Holy Scripture, editors and biographers of the Fathers, antiquarians, annalists, paleographists,—with scholarship indeed, and criticism, and theological knowledge, admirable as often as elicited by the particular subject on which they are directly employed, but conspicuously subordinate to it.

Instances in point.

If we turn to other contemporary Congregations of St. Benedict we are met by the same phenomenon. Their labours have been of the same laborious, patient, tranquil kind. The first name which occurs to us is that of Augustine Calmet, of the Congregation of St. Vanne. His works are biblical and antiquarian;—a literal Comment on Scripture with Dissertations, a dictionary of the Bible, a Comment on the Benedictine Rule, a history of Lorraine. We cast our eyes round the Library, in which we happen at the moment to be writing; what Benedictine authors meet them? Their is Ceillier, also of the Congregation of St. Vanne; Bertholet, of the same Congregation; Cardinal Aguirre of Salamanca; Cressy of Douai; Pez of Mölk on the Danube; Lumper of St. George in the Hercynian Forest; Brockie of the Scotch College at Ratisbon; Reiner of the English Congregation. Their Works are of the same complexion,—historical, antiquarian, biographical, patristical,—calling to mind the line of study traditionally pursued by a modern ecclesiastical congregation, the Italian Oratory. We do not speak of Ziegelbauer, Francois, and other Benedictines, who might be added, because they have confined themselves to Benedictine Antiquities, and every order will write about itself.

Like the Italian Oratory.

Further test. And so of the Benedictine Literature from first to last. Ziegelbauer, who has just been mentioned, has written four folio volumes on the subject. Now one of them is devoted to a catalogue and an account of Benedictine authors;—of these, those on Scripture and Positive Theology occupy 110 pages; those on history, 300; those on scholastic theology, 12; those on polemics, 12; those on moral theology, 6. This surprising contrast may be an exaggeration of the fact, because there is much of repetition and digression in his survey, and his biographical notices vary in length; but, after all allowances for such accidental unfairness in the list, the result must surely be considered as strikingly confirmatory of the account which we have been giving.

Recapitulation. But we must cut short an investigation, which, though imperfect for the illustration of its subject, is already long for the patience of the reader. All human works are exposed to vicissitude and decay; and that the great Order of which we have been writing should in the lapse of thirteen centuries have furnished no instances of that general law, is the less to be expected, in proportion to the extent of its territory, the independence of its separate houses, and the local varieties of its constitution. To say that peace may engender selfishness, and humility become a cloak for indolence, and a country life may be an epicurean luxury, is only to enunciate the over-true maxim, that every virtue has a vice for its first cousin. *Usum non tollit abusus;* and the circumstance that Benedictine life admits of corruption into a mode of living which is not Benedictine, but its very contradictory, cannot surely be made an argument against its meritorious innocence, its resolute cheerfulness, and its strenuous tranquillity. We are told to be like little children; and where shall we find **The Benedictines unscientific and poetical,** a more striking instance than is here afforded us of that union of simplicity and reverence, that clear perception of the unseen, yet recognition of the mysterious, which is the characteristic of the first years of human existence? To the monk heaven was next door; he formed no plans, he had no cares; the ravens of his father Benedict were ever at his side. **in their course of life,** He "went forth" in his youth "to his work and to his labour" until the evening of life; if he lived a day longer, he did a day's work more; whether he lived many days or few, he laboured on to the end of them. He had no wish to see further in advance of his journey, than where he was to make his next stage. He ploughed and sowed, he prayed, he meditated, he studied, he wrote, he taught, and then he died and went to heaven. He made his way into the labyrinthine forest, and he cleared just so much of space as his dwelling required, suffering the high solemn trees and the deep pathless thicket to close him in. And when he began to build, his architecture was suggested by the scene,—not the scientific and masterly conception of a great whole with many parts, as the Gothic style in a later age, but plain and inartificial, the adaptation of received fashions to his own purpose, and an addition of chapel to chapel and a wayward growth of cloister, according to the occasion, with half-concealed shrines and unexpected recesses, with paintings on the wall as by a second thought, with an absence of display and a wild, irregular beauty, like that of the woods by which he was at first surrounded. And when he would employ his mind, he turned to Scripture, the book of books, and there he found a special response to the peculiarities of his vocation; for there supernatural truths stand forth as the trees and flowers of Eden in a divine disorder, as some awful intricate garden or paradise, which he enjoyed the more because he could not catalogue its wonders. Next he read the Holy Fathers, and there again he recognized a like ungrudging profusion and careless wealth of precept and of consolation. And when he began to compose, still he did so after that mode which nature and revelation had taught him, avoiding curious knowledge, content with incidental ignorance, passing from subject to subject with little regard to system, or care to penetrate beyond his own homestead of thought,—and writing, not with the sharp logic of disputants, or the subtle analysis of philosophers, but with the one aim of reflecting in his pages, as in a faithful mirror, the words and works of the Almighty, as they confronted him, whether in Scripture and the Fathers, or in that "mighty maze" of deeds and events, which men call the world's history, but which to him was a Providential Dispensation.

in their habitat,

in their architecture,

in their study of Scriptures

and of the Fathers,

in their style of composition.

Here the beautiful character in life and death of St. Bede naturally occurs to us, who is, in his person and his writings, as truly the pattern of a Benedictine, as is St. Thomas of a Dominican; and with an extract from the letter of Cuthbert to Cuthwin concerning his last hours, which, familiarly as it is known, is always pleasant to read, we break off our subject for the present.

Instance of St. Bede,

Account of his last days.

"He was exceedingly oppressed", says Cuthbert of St. Bede, "with shortness of breathing, though without pain, before Easter Day, for about a fortnight; but he rallied, and was full of joy and gladness, and gave thanks to Almighty God day and night and every hour, up to Ascension Day; and he gave us, his scholars, daily lectures, and passed the rest of the day in singing the Psalms, and the night too in joy and thanksgiving, except the scanty time which he gave to sleep. And as soon as he woke, he was busy in his customary way, and he never ceased with uplifted hands giving thanks to God. I solemnly protest, never have I seen or heard of any one who was so diligent in thanksgiving.

"He sang that sentence of the blessed Apostle Paul, 'It is a dreadful thing to fall into the hands of the Living God', and many other passages of Scripture, in which he warned us to shake off the slumber of the soul, by anticipating our last hour. And he sang some verses of his own in English also, to the effect that no one could be too well prepared for his end, viz., in calling to mind, before he departs hence, what good or evil he has done, and how his judgment will lie. And he sang too the antiphons, of which one is, 'O King of Glory, Lord of Angels, who this day hast ascended in triumph above all the heavens, leave us not orphans, but send the promise of the Father upon us, the Spirit of Truth, alleluia'. And when he came to the words, 'leave us not orphans', he burst into tears, and wept much. He said, too, 'God scourgeth every son whom He receiveth', and, with St. Ambrose, 'I have not so lived as to be ashamed to have been among you, nor do I fear to die, for we have a good Lord'.

He works to the end.

"In those days, besides our lectures and the Psalmody, he was engaged in two works; he was translating into English the Gospel of St. John as far as the words, 'But what are these among so many', and some extracts from the *Notæ*[39] of Isidore. On the Tuesday before Ascension Day, he began to suffer still more in his breathing, and his feet were slightly swollen. However, he went through the day, dictating cheerfully, and he kept saying from time to time, 'Take down what I say quickly, for I know not how long I am to last, or whether my Maker will not take me soon'. He seemed to us to be quite aware of the time of his going, and he passed that night in giving of thanks, without sleeping. As soon as morning broke, that is on the Wednesday, he urged us to make haste with the writing which we had begun. We did so till nine o'clock, when we walked in procession with the Relics of the Saints, according to the usage of that day. But one of our party said to him, 'Dearest Master, one chapter is still wanting; can you bear our asking you about it?' He answered, 'I can bear it; take your pen and be ready, and write quickly'. At three o'clock he said to me, 'Run fast, and call our priests, that I may divide among them some little gifts which I have in my box'. When I had done this in much agitation, he spoke to each, urging and intreating them all to make a point of saying Masses and prayers for him. Thus he passed the day in joy until the evening, when the above-named youth said to him, 'Dear Master, there is yet one sentence not written'; he answered, 'Write quickly'. Presently the youth said, 'Now it is written'; he replied, 'Good, thou hast said the truth; *consummatum est;* take my head into thy hands, for it is very pleasant to me to sit facing my old praying place, and thus to call upon my Father'. And so, on the floor of his cell, he sang, 'Glory be to Father, Son, and Holy Ghost', and, just as he had said 'Holy Ghost', he breathed his last, and went to the realms above".

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[39] The Bollandists have not been able to determine which of St. Isidore's works is here intended; it is not wonderful that we have as little succeeded in the attempt.

He dies working and giving thanks,

It is remarkable that this flower of the Benedictine school died on the same day as St. Philip Neri,—Thursday, May 26; which in Bede's instance was Ascension Day, and in Philip's the feast of Corpus Christi. It was fitting that two saints should go to heaven together, whose mode of going thither was the same; both of them singing, praying, working, and guiding others in joy and exultation, till their very last hour.

like St. Philip Neri.

JOHN H. NEWMAN.

[*To be continued.*]

Art. II.—*On the influence which the Physical Geography, the Animal and Vegetable Productions, etc., of different regions exert upon the Languages, Mythology, and early Literature of Mankind, with reference to its employment as a test of Ethnological Hypotheses.*

BEYOND the ordinary phenomena of organic life, stand the still more complex ones revealed to us by the contact of soul and matter. Placed upon the ever-changing surface of the globe, and composed, physically speaking, of the same materials as that globe, and affording in their arrangement the example of the greatest complexity of organization known, man must necessarily be subject to all the agencies which operate upon matter.

Physical causes influence the food, etc., of mankind,

That the different characters of the food, clothing, amusements, and tastes of different peoples, depend in a marked degree upon the climate, geographical position, and physical conformation of each country, will, we are sure, be at once conceded. So doubtless will also be the proposition, that the size, strength, colour, and the outlines of the external form of men, must in some measure be influenced by the action of surrounding nature. Might we not also add, that the diseases to which mankind is subject change in kind and in intensity within certain limits, when the physical conditions under which life is carried on are altered?

and also the operations of the mind.

The above propositions being admitted, the corollary to them,—that the operations of the mind itself must be likewise more or less influenced by the action of the physical agencies which govern the life of our bodies,—must, we think, be accepted as true. But how is this influence exerted, to what extent does it act, and how far has it operated in bringing about the phenomena recorded in the history of nations? These are among the greatest questions which can engage the attention of philosophers, alike important as the subjects of abstract science and of every-day life. In the action of history, leaving out of consideration the *direct* government of Providence, we see the results of two sets of causes, of very different value it is true, but both requiring nevertheless to be carefully studied: 1. the absolute action of the mind; and 2. the disturbing action of the physical causes above mentioned. Unless the philosophic historian

Phenomena of history the result of two sets of causes.

can determine the amount of those disturbing causes and eliminate them, he cannot, as we think, properly discuss the relation of cause and effect in treating his subject. That this distinction of causes is but imperfectly understood by the generality of historians, we think it would be easy to show. As one example, we would merely refer to the substratum of error upon the unhappy subject of races, which underlies so much of modern history.

Proposed science of the action of physical causes upon mankind.

A science of the influence of physical causes upon mankind, materially and intellectually, must obviously be based upon a knowledge of the laws of organic life. This circumstance is indeed alike the source of the great difficulty of the subject and of its imperfect development; for we cannot have much material for study when its chief fundamental science, physiology, can be scarcely said to have as yet a definite existence. We do not know whether we are justified in designating a heterogeneous mass of facts and speculations, which have never been clearly grouped into a whole, as a science. In using the word, however, we do not apply it in the sense in which we would speak of a science of chemistry or physiology, both of which are, comparatively speaking, homogeneous subjects, that is, include phenomena resulting from the operation of the same or analogous causes, but rather in the sense in which we term such a concrete subject as geology a science. Athough the latter includes physical, chemical, and physiological phenomena, and therefore not referable to the same or analogous causes, yet it is obviously convenient to group together under one head all the phenomena connected with the formation and alteration of the Earth's crust. So likewise we might group together a number of subjects which are immediately or remotely connected with the action of physical phenomena upon man, physically and intellectually. This group might consist of anthropology, or the study of the moral and physical constitution of man generally; and ethnology, or the study of the races of mankind, which we may do by two methods: *physiologically*, that is, by the physical characteristics of form of the head, colour, etc.; or *philologically*, that is, by the comparative study of languages. To these we should add such isolated subjects as the influence of physical causes on mythologies, migrations of people, forms of government and laws, industry, etc.

Materials for it.

The past half century has been very prolific in materials—understanding by that term not only facts but also speculations—for the anthropological and ethnological portions of the science. The whole literature of the other or more purely intellectual branches, consists of some passing allusions in the works of a few authors. In the construction of the science, as distinguished from the gathering of materials, there has been on the whole perhaps no very great advance made. Numerous speculations have been broached, but, with few exceptions, none of them could even serve as useful scaffolding. Nor is this to be wondered at, remembering the extreme difficulty of the whole subject, and its comparative youth among the branches of human knowledge.

Present etymological methods defective.

Few, we believe, will be disposed to deny that the present method of etymological investigation is not such as would satisfy the strict logical requirements of a scientific method. There appears to us, perhaps as the result of the defective method, a striving after the discovery of laws of the greatest possible generality before the inferior ones are established, thus anticipating the progress of the science. Considering philology as an inductive science, the general treatment of the subject is decidedly metaphysical, and the results proportionally vague and uncertain. Even the most scrupulous etymologist often analytically proves that a whole group of words has been formed from a common root, although no possible logical connection can be traced between the ideas which they symbolize. We admit that it can be historically proved that many words have been derived from a common stock, whose corresponding ideas do not exhibit the remotest relationship. Here, however, we can apply the test of history; but where we have not history to aid us, how are we to verify our analysis? for without verification the result of any analysis can only be a possibility, at best but a probability. Some material test, then, is wanted by which the fundamental results of etymological analysis may be verified.

Philological methods generally imperfect.

We have spoken chiefly of etymology in the preceding paragraph, because it is the foundation upon which the whole superstructure rests; but the imperfections are not confined to the basis. For instance, what can be more arbitrary than the principles of the classification of languages? No two philologists seem to agree about the comparative values of affinities; generic ones being frequently confounded not only with specific, but even with class affinities

Causes which produced diversity of languages.

Three principal causes have obviously operated in creating from the primitive mother-tongue, the great diversity of languages which now exists: 1. intellectual idiosyncrasy; 2. influence of physical agencies; 3. and mixtures and contact of peoples speaking different languages. Of these, the second is, perhaps, the most important, and the least studied, no doubt because it is the most difficult. But whatever opinion may be formed of its importance, its action certainly pervades all the phenomena of language, and must be estimated in order to establish a consistent ethnological history of languages.

Subject to be treated only suggestively.

We are quite sensible of our unfitness to deal with this question of physical influences upon language, etc., especially with the very scanty materials which are available. The defects of plan or arrangement may pass unheeded amidst a profusion of ideas; but poverty of materials only helps to set them in stronger relief. As at best we can only treat the subject suggestively, we may do good service to science by beckoning others more qualified for the task, to enter upon a path which opens into a rich and almost virgin field of research. Trusting, then, to the indulgence of the reader, we will state what we propose to undertake.

What we propose to do.

It is a well known fact that certain articulate sounds are found in one language, or group of languages, which may be wanting in another. It is also well understood that the coördination of phenomena usually leads to the detection of the laws which govern them. Why not then found a geography of articulate sounds by which we might in time discover the laws which govern their geographical distribution, and, perhaps, the solution of the problem of the origin of dialects in languages? Again, all verbs and nouns symbolize either positive material things, qualities, or actions, or did so before they became the symbols of abstract conceptions. The original stock of roots in a language must, consequently, have reflected the character of the climate, physical conformation, geological structure, and fauna and flora of the region where it originated. Among the objects for which names were framed would, doubtless, be many whose geographical distribution would be limited, and therefore determinable. In process of time also a language incorporates words from other languages by contact or fusion of the people speaking it with other nations; some of them, too, might be connected with objects having a determinate geographical position.

If we could discover a number of such words in every language, they would constitute true ethnological fossils, by means of which we could as unerringly refer a language to its original home, and trace the line of its onward movement, as the geologist determines, by means of the remains of the plants and animals entombed in the rocks forming the external part of the Earth, the relative stratigraphical succession of those rocks.

The mythology, too, of a people, and its early poetic literature, are stamped with the character of the region where they grew up, and may, therefore, afford means, in many cases, of determining the point of departure in the migrations of a people, and even of the countries passed through, from the character of the foreign elements picked up by the way, or the traces left behind by itself. Even the course of the migration itself is subject to the influence of the physical conformation and geological structure of the surrounding regions. Finally, the same circumstances, conjointly with geographical position, determine the pursuits of nations, the development, and, to some extent, the character of their creative arts and of their social organization, while these, in turn, react upon the form of their government and their laws.

How we propose to do it.

The first two categories of our subject are pure philological problems, and their solution consequently demands the application of philological methods of investigation. Now, as our mode of treating these questions must naturally assume the form of an essay rather than of a scientific memoir, we must make the results of previous philological inquiry, to a great extent, our basis. In order to be perfectly intelligible, we must introduce the subjects, of which we have just given the programme, by a preface or brief summary of so much of the methods and results of philological ethnology as we may have occasion to refer to subsequently. After mature deliberation concerning the best and shortest method of effecting this object, we have decided upon the following: We shall take some leading ethnological hypothesis, and having first stated it in the terms of its authors, we will then briefly mention the etymological principles according to which the investigation of languages, upon which it is founded, have been conducted; the chief grammatical characteristics which serve as the basis of the classification of those languages, illustrating the latter by a short sketch of the grammatical peculiarities of the classes embraced by the hypothesis selected, To render this part the more complete and useful for subsequent reference, we shall then enumerate the chief groups of languages comprised in those classes; and lastly, we propose to give a brief sketch of the method of historical verification applied to the same hypothesis.

All this being done, we will then be in a position to take up the questions whose discussion is our proper object. By thus grafting our subject upon some great and well recognized ethnological hypothesis, its true bearing will be better seen, while it will gain in definiteness, and our means of illustration will be more varied and interesting.

Our shortcomings.

However elementary we may make the summary just sketched, it must still occupy much space. With every desire to compress what we had to say into one article, we have only succeeded in bringing the "introduction" within those limits, and must consequently occupy a second article with our own speculations. But even this division has not prevented a great evil—a long article; and yet, we could not have done otherwise than make a big essay, for we have had to treat, in a few sheets, what might well require volumes to do it properly. We fear that one of the effects of our efforts at compression has been to make a kind of literary breccia, which, in order to be readable, would require to undergo complete fusion.

References to authorities.

We have taken the greatest pains to give references to the original authorities for every important statement, and have even, we believe, corrected some errors which occur in this respect in several esteemed works; but still, as from the nature of such an exposition, it can only be a summary of others' labours, much that does not belong to us will be found unacknowledged, owing to having become common property. There are doubtless many very valuable works and memoirs, which might have been of use to us, which we could not procure, or of whose existence we were ignorant, a circumstance which we regret not only for our own sake, but also because it deprives us of the opportunity of doing an act of literary justice, in naming every labourer in the field.

The Indo-European Hypothesis.

We shall select the "Indo-European Hypothesis", and its corollary, the "Finn Hypothesis". The former may be thus briefly stated. The greater number of European languages exhibit remarkable affinities, both verbally and grammatically, and are hence believed to have had a common origin—that is, were derived from one mother-tongue, which existed as such at some period at or after the development of the primitive mother-tongues of the Semitic, Indo-Chinese, and other great families of languages. In Asia there are also several languages which exhibit a similar affinity, not only among one another, but also with the European ones; this affinity being in some instances stronger between an Asiatic language and an European one, than between two of the latter. The natural conclusion from all this is, that the Asiatic languages had the same mother-tongue as the European; and further, that the races speaking these allied languages are the descendents of one and the same primitive race, the seat of which has been placed in the highlands west of the Mustag and Belurtag chains, towards the Caspian Sea.[1] In this case the European races of the family must have emigrated to the westward, and the Indian ones to the south and east. This occupation of Europe and India by the same family of nations has given rise to the name Indo-European (or Indo-Germanic), by which it is distinguished.

The Finn Hypothesis.

This emigration of the Indo-European race being assumed to have taken place at a comparatively recent period to the first diffusion of mankind, the countries through which that race passed, must have been already inhabited by people of different races, and who were either absorbed, displaced, or exterminated by the immigrating one. Who were those people? History tells us that part was occupied by the Semitic races—namely, Arabia, Syria, Egypt, etc., but leaves us altogether in the dark respecting the aboriginal inhabitants of Europe and of India. It was to meet this difficulty that the Finn hypothesis was proposed; and it assumes that Finns and other allied races belonging to one great family of nations occupied all the countries with the exception of the Semitic empires, through which the Indo-European races passed. The Finns, who have thus obtained such ethnological preëminence, are, properly speaking, the race of that name forming about five-sixths of the population of the Grand Duchy of Finland, and to a smaller extent, of the Russian Government of Archangel. They are an obscure race, who, probably, have not acted any very remarkable part in history, and who appear, almost for the first time in its pages, in the *Germania* of Tacitus,[2] whose notice is by no means flattering. Their immediate alliances are, if possible, more obscure; for among them are the Laplanders, to whom indeed it is probable the observations of Tacitus apply, rather than to the Finns of Finland. It would appear that the Laplanders once occupied all the country as far south as both shores of the Gulf of Finland, and, perhaps, even to some extent along the south shores of the Baltic.[3]

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[1] Lassens, Indische Alterthümer, Bd. 1, S. 526.

Schlözer broaches the idea.

The first person who conceived the idea of the Finn hypothesis, appears to have been Schlözer, who says:[4] "There is a Finn world or Finn stock, which, in the extent of its diffusion on the surface of the old world, is one of the very greatest in the whole history of mankind or of nations, compared to which even the Slavonic race, so far as we know its original limits, was very trifling. Take up a map and measure!—from west to east in the far north, from Finland and Lapland in Norway, the immense tracts on the coasts of the North and Arctic seas as far as the Ural; then from north to south down the west side of the Baltic sea, formerly deep into Sweden and Norway, of both which countries the Finns appear to have been the aboriginal inhabitants; then on the other side of the Baltic, through Finland Proper and Esthonia onwards to the Curische Haff; then also the whole of north-west Russia on this side of the Volga as far down as the Morduins; then beyond that great river from the Ingrians on downwards to the Voguls, Permjaks, and Bashkirs. These races still exist; they are still recognizable in their ancient languages and customs, even although most of them have been pressed forward into the far north by other different races following after them from the south; on one side the Germans, on another the Slaves, and on the third Tatars; but some few have, however, totally lost themselves in the new comers".

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[2] As it may interest many of our readers, we shall give the entire passage from Tacitus:—"Peucinorum Venedorumque et Fennorum nationes Germanis an Sarmatis ascribam dubito, quamquam Peucini, quos quidam Bastarnas vocant, sermone, cultu, sede ac domiciliis ut Germani agunt. Sordes omnium ac torpor: procerum connubiis mixtis nonnihil in Sarmatarum habitum fœdantur. Venedi multum ex moribus traxerunt: nam quicquid inter Peucinos Fennosque silvarum ac montium erigitur, latrociniis pererrant. . . . . Fennis mira feritas, fœda paupertas: non arma, non equi, non Penates; victui herba, vestitui pelles, cubile humus. Sola in sagittis spes, quas, inopia ferri, ossibus asperant. Idemque venatus viros pariter ac feminas alit: passim enim comitantur partemque prædæ petunt. Nec aliud infantibus ferarum imbriumque suffugium, quam ut in aliquo ramorum nexu contegantur. Huc redeunt juvenes, hoc senum receptaculum. Sed beatius arbitrantur, quam ingemere agris, illaborare domibus, suas alienasque fortunas spe metuque versare. Securi adversus homines, securi adversus Deos, rem difficillimam assecuti sunt, ut illis ne voto quidem opus esset".—*Germania*, cap. 46.

[3] See Lehrberg's Untersuchungen über die älteste Geschichte Russlands, S. 201–203; and Sjögren über Finnische Bevölkerung des St. Petersburger Gouvernement, S. 76.

[4] Nestor, Russische Annalen, übersetzt von A. L. Schlözer. Göttingen, 1802. Th. III., S. 116–117. The passage is also quoted in Slowanské Starozitnosti sepsal Pawel Josef Safarjk, etc., Praze, 1837". See also German Translation under the title, "Paul Joseph Schafarik's Slawische Alterthümer". Leipzig, 1843—1844".

Rask's view.

This idea of Schlözer was favourably received by many philologists, who successively extended it so as to include finally nearly the whole of Europe and Asia; but it is especially to Rask that the Finn hypothesis in a definite shape is due. He conjectured that the Tchudes, a name applied to the Finns and a number of allied peoples, formerly possessed the whole of modern Sweden, Norway, and Denmark.[5] He also considered that the northern family of nations, of which the Tchudic or Finnic races formed an element, had spread over a wider geographical area than any other in the world. "Thence it follows", he says,[6] "that the people of this race who are now found uninterruptedly from Greenland over the northern part of North America, Asia, and Europe as far as Finland, must have lived in very ancient times much farther into Europe;—on the one side to the Elbe, Britain, Gaul, and Spain; on the other from the White Sea to beyond the Caucasus. It would appear as if in prè-historic times, before the spread of the Indo-European race, a considerable part of the modern Europe was first occupied and for a long time inhabited by races of this family, which at a later period were partly annihilated, partly dispossessed and driven into the northern regions, by peoples of Indo-European origin—namely, by Kelts in Gaul and Britain, by Germans in Germania and Scandinavia,[7] and by Slaves in the Trans-Carpathian countries. The northern races also filled, as already observed, the whole of northern and middle Asia, regions which must be considered as their original home. Here the central Asiatic mountains were their shield against other races, and their immense population preserved them here from the fate which befell the smaller races belonging to the family in flat, open, everywhere accessible Europe".

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[5] Rask, Ueber die Uersprung der Altnordischen Sprachen. Stockholm, 1818, S. 112—146 (also quoted in Schafarik's Slawisch. Alterth., Bd. I. 29).

[6] Rask, in Nyerup Magazin. Kjopenhavn, 1820, I., quoted in Schafarik, who also gives Wiener Jahrb. der Liter., 1822, Bd, 15. He also mentions the title of another work of Rask's, in which allusion is made to this, but which we have not seen, namely, "Ueber die Zendsprache nebst einer Uebersicht des Gesammten Sprachstammes. Uebersetzt von F. H. v. d. Hagen" S. 69—72.

[7] Upon the supposition that *Jötunheimr*, in the Scandinavian sagas, refers to the land of the Tchudes, and Iötnar to the Tchudes themselves, Rask has attempted to prove that Jütland in Denmark [Scan-

The preceding passage expresses the hypothesis in its very widest extension, and we need not, therefore, dwell further on the subject, than to observe that it is the greatest conception with which the science has been enriched within the present century, and one which has undoubtedly served the chief purpose of all such speculations, namely, as scaffolding for further researches.

Basis of the Hypothesis.

This hypothesis (considering the two but as one) is not a mere guess; right or wrong it is founded upon the result of comparative etymological and grammatical investigations of the languages of Europe and Asia, more or less aided by historical inquiry. The amount of truth which it contains must depend upon the correctness of the methods of research, and upon the care and skill with which they have been employed. We could not possibly describe those methods in detail, but the short sketch which we propose to give of those parts which concern our own peculiar subject, will give a sufficient idea of their general character. The points we shall notice will be: 1. the nature of roots and the formation of words; 2. the phonetic laws which govern the combinations of syllables in a language, or the gradual modification in time of the latter, or the passage of words from one language into others. These two points will require to be prefaced with some observations on the formation and classification of articulate sounds; 3. the comparative grammatical organization of different languages. In accordance with this scheme we shall now proceed to consider the formation and classification of sounds.

Production of articulate sounds.

The lungs, the larynx, the mouth, and the nose are the organs used in the production of articulate speech: the aspiration, voice, and consonantal articulation are the agents. The aspiration is simply a stronger breathing which helps to give force and effect to vocal sounds, and will be best understood by the difference

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dinavian *Jotland*] derives its name from Iötnar, and that consequently the Tchudes must have formerly possessed Denmark. J. Grimm makes a similar remark, *Deutsche Mythologie*, Dritte Ausgabe, I. bd. S. 487.

between the pronunciation of *ha* and *ah*. The voice is the tone produced when the air in passing through the contracted opening of the glottis sets certain ligaments *(chordæ vocales)* in rapid vibration.

Two kinds of articulate sounds.

The sounds constituting articulate speech are of two kinds, vowels and consonants; the former are produced by the passage of the air through the opening of the glottis; the latter are formed above the glottis in the vocal tube or in the cavity of the mouth or nose, by the air simply rushing between surfaces differently modified.[8] The modifications effected in these different organs constitute what is termed articulation. If the vocal chords be relaxed, and do not consequently vibrate during the passage of the air through the glottis, we only produce the mute or whispered vowels; if the vocal chords be tense, and vibrate, we get true intonated vowel sounds, which, at the same time that they constitute elements of speech, partake somewhat of the character of musical tones. In other respects the difference in the character of vowel-sounds depends upon the size of the buccal cavity and the outlet or aperture of the mouth. All consonants, with the exception of a few modifications—or rather we should say all pure consonants—can likewise be produced in whispering without the aid of vocal intonation. Some of them, however, admit of being sounded with a vocal tone as well as without it, while we cannot so sound the others; and if we attempt to sound them aloud, we merely produce a combination of the consonant with a distinct vowel. This circumstance serves as an important element in the classification of consonants, as we shall hereafter see.

Classification of vowels.

It has been historically as well as physiologically proved, that the earliest and chief vowels were *a*, *i*, *u*; *e* and *o* having been formed later as intermediate, though nevertheless perfect, vowels—*e* lying between *a* and *i*, and *o* between *i* and *u*. Besides these perfect vowels, there are the mixed or obscure vowels, *ä*, *ö*, *ü*, resulting from the fusion of *i* with *a*, *o*, *u*. These are not diphthongs, but on the contrary may be long or short. The intermediate perfect vowels *e* and *o* have more vowel character than *i* and *u*, and hence *a*, *e*, *o*, are termed liquid or flowing vowels, and *i* and *u*, inflexible or consonantal vowels. This difference of character enables the liquid vowels to yield an infinity of delicate shades.

Value which we attach to each vowel letter.

As unfortunately the same letter is not used in every language to express the same physiological sound, it might lead to misconception if, before proceeding farther, we did not determine the precise values which we attach to each vowel letter. The chief perfect vowels, *a*, *i*, *u*, recur in all languages, and the intermediate perfect ones, *e* and *o*, in most. On this account we think it more correct, when treating of languages from a scientific point of view, that each simple sound should be represented by a simple letter; that is, that the five definite physiological pure vocal sounds, produced by varying the size of the mouth aperture, etc., should be expressed by the five simple letters used in modern European alphabets for vowel sounds. This may present some difficulty at first to those who are accustomed to consider only the particular sounds which these letters represent in their own language. Thus, for example, the pure vowel sound of *a* exists in English in the *a* in *far;* of *o*, in most words in which that letter occurs. But the letters *e*, *i*, *u*, do not represent perfect vowel sounds, but mixed ones, and we have accordingly to look for the true simple vowel sounds under others; thus,—*e* will be found to be best represented by the *a* in *name; i* by the *e* in *theme;* while *u* is expressed by the *oo* in *cool*. The German *u* is the true sound, but the French and Dutch *u* are mixed sounds, the true simple sound being expressed in the former by *ou*, and in the latter by *œ*. Our *a*, *e*, *i*, etc., are, therefore, to be understood as expressing the true physiological sounds, the values of which in English we have just given. The advantage of this system will be best understood when we come to speak of diphthongs, for when we know the precise value of the simple sounds, it is easy to determine that of any possible compound.

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[8] J. Müller—Elements of Physiology. Translated by Baly. London, 1843, vol. ii., p. 1016.

Organs which produce consonants.

The organs of the mouth which produce articulation are the lips, tongue, and teeth, acting pair-wise in the production of consonants, one part being active, moveable, and pressing on the other; namely, the under lip, the fore part of the tongue, and the back part of the tongue, on one side, and the upper lip, teeth, and palate, on the other. The consonants differ essentially in character according as they are chiefly articulated by one or the other organ, and may accordingly be classified into *labials*, or those produced by the lips, *dentals* by the teeth, and *palatals* by the palate. Besides these, several intermediate sounds have been developed in some languages, such as the lingual or cerebral of the Sanscrit, which lie between the dentals and palatals, or, as in other languages, the labial-linguals, in the formation of which the lips act, and the glottal or guttural of many languages, which are produced lower down in the throat than the palatal. As the vibrating column of air, which produces voice, can pass through the nose as well as through the mouth, we may get nasal modifications of all the vowels and of a number of the consonants; but, as these sounds, when much developed, are disagreeable, most people avoid them, although there are some, like the sounds of *m* and *n*, and especially the latter, which cannot be produced without the intervention of the nose; indeed the former passes into *b* if we attempt to sound it by the mouth alone. The aspiration in speaking only passes through the mouth, and is of two kinds, the *spiritus lenis* and *spiritus asper*. These terms

Spiritus lenis and asper.

were first applied to the marks by which the Greeks distinguished in writing those initial vowels of words, which were to be aspirated, for they had the aspirate only at the beginning of words. Other nations distinguish the *spiritus asper* by a peculiar letter, for example, *h*, but have no mark for the *lenis.* They are both, as J. Müller says, the simplest expression of the resonance of the mouth-walls during the expiration of the air without any hindrance of the organs of the mouth. They may, therefore, be considered as the weakest and shortest explosive consonant sounds, and in this sense some writers, as for example, Rapp,[9] look upon the *spiritus lenis* as the first beginning of a consonant, and instances the circumstance that if we pronounce any vowel as *e*, tending towards the mixed vowel *ä* or *ö*, etc., we pronounce in reality two sounds; along with the fundamental vocal sound we have also the fundamental consonantal one. He even goes further, and says, that it is a law that no vowel sound can be pronounced without an accompanying consonantal one, but that none beside the fine ear of the Greeks had ever fully seized this elementary consonant, and fixed it under the name of *spiritus lenis.* Other writers[10] think that the *lenis* has only a negative character,—that it only indicates where no *asper* or true *h* aspiration occurs.

The aspirate may precede or follow the vowel, or may even completely penetrate it, and being produced by the resonance of the expired air during the repose of the vocal chords of the glottis, it ceases, that is, passes into the voice, the moment the column of air is set in vibration: aspiration and voice are therefore really inseparable.

Agents which produce consonants.

Consonantal articulation being merely the organ or instrument of speech, can only produce audible sounds by the agency of the voice or of aspiration. This circumstance introduces the new element of classification among the consonants above referred to. We have in the first place those formed through the agency of the intonation of the voice, or vocal consonants, which, if the articulation be incomplete, have a certain vowel character, and are hence called *semi-vowels*, *w*, the German and French *j*, etc. If, on the other hand, the articulation be complete, we have the *liquid consonants (Literæ consonantes liquidæ)* which are of two kinds, *oral (orales)*, *l*, *r*, and *nasal (nasales)* *m*, *n*, *ng*, etc., according as the voice escapes through the mouth or nose. If incomplete consonantal articulation be rendered audible by the aspiration or breath passing through the mouth during the aspiration itself, which can only of course be done by the organs simply approach-ing, the articulation is as it were completely penetrated by the aspiration, and we get the aspirated continuous consonants *f*, (sharp) *s* (double ss), *ch*, etc., and the mixed sounds of *s* and *ch*—*sch* in German, or English *sh*. As the half vowels, liquids, and aspirants are so formed that the voice and the breath go through the mouth or nasal canal, more or less open, while the phonetic organs do not change their place during the production of the sounds, these consonants are, like vowels, continuous sounds, and are hence termed *continuous consonants (L. c. continuæ)*. When the aspiration follows a complete articulation, which it must do in every such case, because the breath is arrested or barred for a moment by contact of the articulating organs, the *mutæ* or *mute consonants*[11] are produced. In this case the aspiration may be *spiritus lenis* or *asper*, the first giving the common inflexible consonants divided into the *soft mutes (mediæ)*, *b*, *d*, *g*, and the *hard mutes (tenues)*, *p*, *t*, *k;* the *asper* gives the *aspirated mutes* (*aspiratæ*), *bh*, *dh*, *gh* (in Sanscrit), and *ph* (φ), *th*, (θ), *kh* (χ) in Greek, Sanscrit, English, etc. The sound of the mutes is momentary, and is the result of a sudden explosion of the air forced through the organs, and more or less arrested during the articulation, and only becoming audible the moment the pressure is relieved. Hence they are called *explosive consonants (L. c. explosivæ)*. A marked distinction between explosive and continuous consonants is, that in pronouncing the former the vowel follows the consonant, in the latter it precedes it, with some trifling exceptions.

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[9] Versuch einer Physiologie der Sprache. Von Dr. K. M. Rapp. 1ster Bd. 1836, S. 53.

[10] Valentin-Lehrbuch der Physiologie des Menschen (Erste Aufl. 1844), 2ter Bd., S. 291.

Classification of consonants.

Consonants formed by the same organs, such as dentals, etc., may be called *homorganic;* but homorganism could not form the basis of a true classification of consonants, because sounds would thereby be included in the same category, which, in accordance with physiological principles, would be distinct. Some physiologists are of opinion that the production of any given sound depends less upon the accurate arrangement of particular articulating organs, than upon the fulfilment of definite physical conditions which may be expressed by a determinate geometrical figure; or, in other words, different individuals may produce the same sound by different means.[12] Consonants formed by the same kind of action may be called *homogeneous*, a character which affords the truest foundation for a classification. But although the classification of all consonants into homorganic categories be not scientifically correct, it is so within the limits of each homogeneous category. Thus there is a wide distinction between *l* and *d*, though both would be classed as dentals. A common quality of this kind is obviously not one which could form the basis of *class* distinctions. On the other hand, *l* and *r* are oral liquids, and may consequently be physiologically classed together; but the former is dental, and the latter palatal, qualities, which, though not capable of founding class distinctions, are well fitted to mark generic ones. The best classification is that which includes both distinctions founded upon homogeneous and homorganic relations, the latter being subordinate to the former. In order to render this classification of consonants more intelligible, we shall give it in a tabular form, which we borrow from Heyse.[13] The letters in the same horizonal line are homogeneous, those in a perpendicular line homorganic:

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[11] So called because they do not admit of vocal intonation.

[12] Emil Harless, in the article "Stimme", in "Wagner's Handwörterbuch der Physiologie". Bd. iv. Braunschweig, 1853. S. 704.

A.—CONTINUOUS CONSONANTS.	Labial.	Dental.	Palatal.
I. *Aspirants* (also Sibilants), articulation imperfect, penetrated by the aspiration (these are intimately related to the class of mute consonants),	*f*	*s* (sharp) *ss*, *c*, etc.	*ch*
		sch (German), or *sh* English, etc.	
II. Vocal or Intonated Consonants: 1. *Semi-vowels:* Articulation imperfect, penetrated by the voice,	*w*	*s* (soft=*z*)	*j*
			French *j*, etc.
2. *Liquids:* Articulation perfect, penetrated by the voice, which may pass either through:—			
a, the mouth producing *oral*, .	—	*l*	*r*
or *b*, the nose giving *nasal*, .	*m*[14]	*n*	*ng*
B.—EXPLOSIVE CONSONANTS.			
III. *Mutes:* Articulation perfect, with succeeding aspiration,			
1. With *Spiritus Lenis:*—			
a, soft (*mediæ*), . . .	*b*	*d*	*g*
b, hard (*tenues*), . . .	*p*	*t*	*k*
2. With *Spiritus Asper*, *Aspiratæ:*—			
a, soft, ...	*bh*	*dh*	*gh*
b, hard, . . .	*ph*	*th* ϑ	*k h* χ

Length of vowels.

A vowel being a flowing or continuous sound, may be of indefinite length if we could continue to force air through the glottis; in articulate speech it is, however, of a definite duration, the minimum being assumed as the standard.[15] As the vowels are of secondary importance in speech, and merely intended to sound the articulate consonant or vehicle of the ideas, the vowels of the first or primitive syllables are considered to have all been short. In the progress of development of language, the duration may be increased, partly for euphony' sake, and partly in order to express grammatical and other differences. The lengthening can, however, only take place by the junction of a new vowel element. This may or may not be identical with the first. In the first case, the result will be long vowels; in the second, diphthongs. But although the long vowel is the short vowel twice taken, it is not spoken by two successive efforts, but is one perfectly homogeneous sound of double the duration of the short one. The diphthong is also the fusion of two vowel sounds into a continuous sound; but in this case the vowels are different, and more or less of their individual character is maintained—that is, it is a heterogeneous sound unity. The mixed vowel, on the other hand, is a homogeneous one; but the diphthong often passes into it, and even into a simple long vowel. Every combination of two short vowels does not produce a true diphthong. If we arrange the vowels in the order from the highest to the deepest, thus: *i*, *e*, *a*, *o*, *u*, it will be found that the passage from the middle vowel *a*, towards *i*, on one side, and *u* on the other—that is, the combination of a flowing or initial with a fixed or final vowel alone, produces a true diphthong; the initial vowels are, accordingly, *a*, *e*, *o*, and the final *i*, *u*. The reverse arrangement does not produce the full flow; a hiatus will occur between the component vowel sounds, or the final one will pass into a half vowel *j*, and form a syllable. This contrast will be easily observed by sounding *ai*, *au*, and *ia*, *ua*. There can, consequently, be only six true diphthongs, *ai*, *au*, *ei*, *eu*, *oi*, *ou*. The false or imperfect diphthongs include all other vocal combinations of short vowels, such as *ae*, *ao*, *ea*, *eo*, *ia*, *ie*, *io*, *iu*, *ua*, *ue*, *ui*, *uo*. The first two are the links between the two classes, belonging, perhaps, as much to the true diphthongs as to the imperfect ones.

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[13] Die Sprachwissenschaft. S. 269.

[14] According to J. Muller (Elements of Physiology, vol. ii., p. 1047), in the pronunciation of *m*, *n*, and *ng*, the air passes simply through the nasal canal, the aperture of the mouth being closed either by the lips or by the tongue being pressed against the palate, and without suffering any opposition. The mouth is closed by the lips while *m* is spoken, but "the sound is not produced by this act of closing of the lips, but after they are closed, by the simple passage of the air through the nasal cavity, together with the resonance of the diverticulum formed by the cavity of the closed mouth". On this account he does not consider *m* to be a labial sound. This circumstance is of considerable philological importance, though the distinction does not appear to have been hitherto appreciated by philologists.

[15] If any given vowel be prolonged, as in singing, we very soon lose

Diphthongs.

Gemination, or the doubling of consonants, corresponds to long vowels. The analogy of the diphthong among the consonants also occurs in the combination or fusion of two or more consonants; and like the diphthongs, such combinations are not arbitrary, but take place according to certain laws, that is, only certain letters can thus fuse. These laws differ according as the consonant is initial, final, or internal, that is, in the middle of the word.

Gemination.

The combination of a consonant and a vowel constitutes a syllable (συλλαβή): indeed the mere pronunciation of a conso-

The syllable.

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the power of distinguishing which it is, that is, it ceases to be a true articulate sound.—Professor Willis, "*Cambridge Philosophical Transactions*", vol. iv., 1832.

nant constitutes a syllable, because it may be asserted that no consonantal sound is possible without an accompanying vowel. In Tamulic it is beautifully said, that the consonant is the body, the vowel the soul, and the syllable the soul and body. But in a more general sense, a syllable is any word, or part of a word, which is formed by a break or pause in the voice; in this way a vowel or diphthong may be considered a syllable. But it would be what is called a naked syllable; combined with one consonant, it is said to be clothed, and is *open* or *closed* according as the consonant precedes or follows the vowel; if a vowel be included between two consonants, the syllable is enclosed. It has never yet been ascertained whether all syllables were originally open; but if, as in the nature of things must be the case, the roots of all languages be monosyllabic—a result which has been obtained by analytic investigations even in the case of the highly developed languages—either this is not the case, or we have not obtained in every instance the original form of the root, for several roots occur which are enclosed syllables. In what are called the monosyllabic languages, however, open syllables appear to be the rule.

First syllables expressed both nominal and verbal ideas.

The object of every perception is perceived under two circumstances, space and time, or what we might term statical and dynamical conditions: 1. as occupying, and therefore existing in, space—therefore, a thing, an object, or a fixed quality; and 2. as changing, existing in time, and, therefore, motion, action. The first phonetic combinations, or articulated syllables symbolic of ideas, must have expressed both conditions—statical and dynamical; that is, must have been capable of expressing the ideas represented by nouns and verbs, which together constitute the matter or substance of language. They were not, however, necessarily either nouns or verbs, but materials for both.[16] To these first rudimentary words (the ὄνομα and ῥῆμα of the Greeks, or φωναὶ σημαντικαὶ of Aristotle) the term root is applied. A root, or the definite articulate sound by which man first expressed his conception of any phenomenon, did not denote either the subject or the action, but the whole concrete occurrence as it affected his senses. But as the verb expresses the being, the action, the root may present itself in subsequent stages of the language in the verbal form, frequently as the infinitive, whenever the dynamic condition of the phenomenon happened to be the most important. In other cases the noun or adjective form may best express the value of the root.

The root had the

The root representing the concrete occurrence—that is, verb and subject—had the symbolic value of an entire sentence; but this sentence must have been very indeterminate, no fixed time being denoted; or rather it was *aoristic*, the past, present, and to some extent the future, being included. The person, like the tense, would not be expressed by any special contrivance, but the third person, which is that of narrative, would almost invariably be implied.[17]

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[16] Bopp Vergleichende Grammatik, S. 105. W. v. Humboldt, Die Kawi Sprache (Einleitung), S. cx. Becker (Organism der Sprache, 2te neu bearbeitete Ausgabe, 1841, S. 83) is of a different opinion; he says, "All root-words in a language are verbs, and all radical conceptions, conceptions of action".

value of a sentence.

The idea that the roots are rather the materials for verbs and nouns, than either of them properly, receives corroboration from the study of those languages which have not yet developed themselves beyond the condition of an assemblage of roots without grammatical forms; for it is assumed that a period must have occurred in the history of the development of every language, when it consisted only of unmodified roots.[18] Thus, for example, the Chinese syllable *ta* may mean *great*, *size or greatness*, *to be great*, *to enlarge*, *very*, according to its position, combination, and relation to other words. According to K. Meyer, a similar circumstance may be observed even in such a developed language as the old Egyptian: for example, *mis mus*, the child-suckles; *him mis*, the woman bears; *mon her*, the shepherd drives; *her mon*, the driver herds.[19]

The view that roots are only materials for nouns and verbs corroborated.

A language composed wholly of roots of verbs and nouns could but imperfectly express the proportions or relations in space or time under which the subject contemplates or thinks of the object, such as number, the pronouns, beyond, down, etc., or those perfectly subjective determinations of thought, logical relations, and expressions of the will, such as affirmation, negation, doubt, question, object, cause, etc. In order to express all those complicated relations, language had to undergo certain modifications. At first the juxtaposition of certain roots with other verbal and nominal roots, would be made to express a particular relation in one position, and another in a different one, like the Chinese syllable *ta*, mentioned above. The roots which would have the value of noun and verb in a sentence made up in this way, would constitute the *matter* or *body*—the chief idea, while the roots, whose value would vary with the relative position to the chief idea, would represent the special relations of space, number, etc. This, then, would be the first stage of development of languages.

First stage of development of language.

As Fichte well observes,[20] a living language changes itself in the inverse ratio of its culture; that is, the more civilized a people becomes, the less progressive change does its language undergo—the sooner does it become fossilized ; the more uncultivated it is, the more the language is modified. We may accordingly expect to find that the languages of those people, who became more or less civilized at an extremely early period in the history of the human race, have been more or less checked in their development ; this is the case, for example, with the Chinese. The reverse of this proposition, that a nation whose language is undeveloped must have been civilized, does not of course follow.

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[17] See J. G. Fichte, Von der Sprachfahigkeit und dem Ursprunge der Sprache—Sämmtliche Werke, Bd. viii., S 313.

[18] An opinion entertained by a great many eminent philologists, but put forward prominently by Benfey among others. Götting. Gelehrt. Anz. November, 1852, S. 1782; quoted by Heyse, Die Sprachwissenschaft, S. 144.

[19] Heyse from Münch. Gelehrt. Anz., December, 1841.

[20] Ante, Note 17.

Second stage, or the separation of the pronominal or particle roots.

The next stage of language development would be where the roots expressing relation of time, number, etc., or what we might conveniently term form roots, would get attached or agglutinated to those constituting the matter of the sentence, and undergo more or less modification for euphony' sake, such as the loss of some letters, etc., but not so much that the original roots could not be in most cases recognized. In this stage of progression the form roots would gradually lose their original *special* meaning, and would acquire a generic one, so that a single root might be made to express the same kind of relation in connection with any number of different nouns or verbs. This loss of special meaning and gain of generic value produces in languages, at this stage of development, an essential difference between the roots which become divided into what we might term *corporal* roots, that is, nominal and verbal roots, as already mentioned, and *formal roots*, (corresponding in some measure to the ἄρϑρον and σύνδεσμος of the Greeks, or φωναὶ ἄσημοι of Aristotle), or the pronominal or particle roots of comparative grammarians.

It will be observed that we have assumed all pronominal or particle roots to have originated from roots which had once verbal and nominal value. We may have assumed too much, because the opinion of philologists is yet unsettled upon this point. There are, no doubt, a great many of this class of roots, the origin of which, despite the action of agglutination, etc., can still be perfectly distinguished even in the most complex languages. Thus, to give a few examples taken at random, which although not going back to original roots, will be, perhaps, more intelligible. We have the French, *pas*, *rien*, *point*, from the original Latin substantives, *passus*, *rem*, *punctum; nihil* from *ne-hilum* (*quod granofabæ ahhæret* Festus) that is, not a fibre ; *not* (Germ. *nicht*) = *ni-wiht* (*wiht* = thing) ; the English affix, *ly;* Anglo-Saxon, *lîk;* Old Saxon, *lîc;* Old English, *liche;* Allemannish, *li;* German *lich*—from Old High German substantive *lih* = body, form (hence German—*Leiche*, a corpse, English—*Lich*gate, the outer gate of a church-yard, *Lich*field, etc.). But it is possible that, as languages became highly symbolic, many of them might have been arbitrarily made.

Roots agglutinated or adhering together, might in process of

Third, or amalgamation stage.

time amalgamate fully together, and then gradually undergo various external phonetic modifications, that is, either destroy or alter its initial or final letters—or internal, that is, change the vowel of one of the roots, etc., so that the formal root would become so indissolubly soldered to the main word as to be unrecognizable as a distinct word. This is the amalgamate or inflexional stage of languages.

Formation of lexicographic words.

When a language becomes amalgamating or agglutinating, the primitive monosyllabic words must necessarily disappear and give place to a new set of words containing them, but modified either by internal changes or external additions. The effect of this modification is to contract the unlimited contents of the roots, and make them permanent symbols of definite conceptions, such as they would temporarily possess in a monosyllabic language, according to their relative position in a sentence. The same root might undergo a great number of modifications, so as to yield several new words, exactly as a root in the free monosyllabic condition might have represented several different ideas according to its relative position to other words. Again, the first words formed may, by the addition of the *formal* roots, give rise to a great number of words having definite grammatical forms. Thus, for example, there is assumed to be a root *flo* or *flu*, which gives the following words, some being nouns, some verbs—the root in each word being marked in Italics: English—*flo*w, *flo*od; German—*flu*ss; Latin—*flu*o, etc. From these are derived such words as *flowing*, *flooded* (probably *flower*, *floral*, *flour*), *fliessen*, *fluere*, *fluent*, etc.

Clothing and unclothing of roots.

The conversion of the root into the word, or clothing it, as we might term it, is so universal, that even in languages which border upon the monosyllabic condition, the naked root very rarely occurs, and almost every word is dissyllabled. In the modern European languages, however, which are undergoing a change which we shall notice presently, the clothing is sometimes worn off the root, and we get many naked roots having the definite meaning of former words. Thus, for example, the word *hand* was in Gothic *handus;* Crimean Gothic, *handa;* and already in Old High German it was reduced to *hant;* and in Old Saxon, Anglo-Saxon, etc., *hand* or *hond*, etc.

First method of forming words from roots

Words are formed out of roots in two ways: first, by a change of the root vowel, or internal word forming; secondly, by consonantal strengthening of the root, or external word-making. The first process may take place in three different ways: 1. by a change of the principal vowels *a*, *i*, *u*, into *e* and *o*—example, *sang*, *sing;* 2. by weakening or obscuring the root vowels *a* and *i* into *e*, and *u* into *o*, as *fall*, *fell;* *tan* (root), *teneo*, *tendo;* 3. by strengthening the root vowel which occurs, (*a*) by lengthening the short vowel, example λαϑ (root) λήϑω Doric λάϑω, *făcio*, *fēci;* (*b*) by diphthonging (guna in Sanscrit) Germ. *biss*, *beissen:*

φαν, φαίνω

Second method.

Word-forming by the second or external process takes place by the addition of suffixes and prefixes. These additions are of three kinds: 1. Reduplication, that is, a repetition of the root itself or part of it, the effect of which is to strengthen the meaning of the root, as for example, *singsong*, *zigzag*, *διδάσχω*. 2. Derivation, that is, by the addition of prefixes and suffixes, which, in the fully developed language, have no meaning of themselves, and do not occur isolated in the language—that is, pronominal or particle roots. The words thus derived are obtained often not directly from the root, but from some simpler word: in either case they are of two kinds, *middle forms* and *branch forms;* the former are those in which the affix is only one letter, or where the end syllable is so grown with the root or stock word, that, when the latter is stripped of the letter or syllable, it does not constitute an independent word—examples: *iron*, *water*, *finger*, *garden*, etc. The branch forms are such derivative words as leave, on removal of the prefix or affix, an intelligible word—examples: with suffix—*golden*, *potter*, *faithful*, *princess*, *darkness;* with prefix—*unripe*, *misfortune*. 3. Composition, which consists in the junction into a compound word of several simple words which independently are intelligible. Every composite word consists of two members, one of which contains the general or fundamental idea of the composite, the other limits or determines it. The fundamental word is generally placed last—as, *glasswindow*, *windowglass*, *beeswax*. Each member of a compound word may itself be compound, but this does not affect the dualistic character of the word which such compounds may form: thus, we have *fullmoonshine*, and German—*ober-landjägermeister*. The formation of compound words may take place in two ways: 1. by juxtaposition of two or more words, which stand in an immediate grammatical relationship with each other, that relationship being expressed by the usual flexions, and which together constitute a concrete whole—examples: *do-nothing*, *greater part*, etc. 2. True composition, which may be, (*a*) the junction of two or more words coming together in their simplest condition, that is, without their relations being generally expressed by flexions, and which may be decomposed again without undergoing any essential change in their meaning, such as *upperlip*, *birthday*, etc.; (*b*) by fusion, that is, the combination of the two members so as to represent a simple conception, their individual meaning, more or less altered, having passed into that of the compound, but neither of them separately having any reference to the compound, which, so far as meaning is concerned, is consequently indecomposable—examples: *penknife*, *snowwhite*, etc. Words formed by true composition being capable of holding together, may serve as materials for new compounds, or as stocks upon which to found derivative words by the addition of prefixes and suffixes—examples: *nut-tree-oil*, *fortnightly* (fourteen-night-ly).

Number of articulate sounds limited,

Our observations upon articulate sounds must have shown, what indeed every one may at once divine, that the possible number of homogeneous sounds is very limited, and even of single sounds of a heterogeneous character. The combination of two sounds to an unity may, no doubt, like the mixture of two colours, produce an infinite number of shades; but as, in the case of colour mixtures, there is a limit to the appreciative power of the eye, so there is also, and a much narrower one, to that of the ear. But no one language possesses the whole even of the comparatively small number of simple sounds above mentioned, and consequently we may expect the same result in the case of the mixed sounds. This difference between the original number of sounds in any two languages must be a most fruitful cause of the production of distinct languages, quite independently of the similar effect which the differential development of the grammatical organization would have.

no language has the whole.

The two opinions about the causes of diversity of languages.

The most striking fundamental phenomenon of ethnological philology is the great number of distinct languages which exist. Connected with this diversity we have to notice two opinions which are at the basis of ethnological speculation. According to one, all languages have originated from one primitive one; according to the other, there have been several distinct primitive languages. Fortunately for humanity's sake, the balance of scientific evidence is decidedly in favour of the first opinion, and each new investigation but helps to clear away some remaining barrier standing in the way of an absolute harmony between religious and scientific doctrine upon this, one of the most vital questions connected with mankind. The doctrine of original unity of language involves the existence of affinities between all languages. Such affinities should also exist between all the languages derived from any one of the primitive languages; and, consequently, the observations which we are about to make fit one hypothesis as well as the other.

Comparative affinities of languages.

The primitive language must have first split into a small number of dialects, each of which, in its turn, may have become the parent or stock of another series, and so on. In order to compare any two languages, then, we should know the degree of relationship in which they stand, for the value of the affinities which they might exhibit would be altogether determined by it. We can best conceive the character of this relationship by comparing the whole series of languages to the members of a great family with its genealogical tree. The sons of the progenitor or father would represent the first derivations from the parent language; the children of each son would bear closer relationship to each other than they would to their cousins the children of the other sons; and so of the grand-children. But the farther we proceed the greater will be the complexity of relationships, because we may have to consider, in the case of a given language, relationships of the same value as those represented by brother, first-cousin, second-cousin, and uncle.

Ways in which languages may differ.

This brings us to consider the several ways in which languages may differ; for it is only when we know this that we can proceed to classify them according to the relative order of their affinities. The sources of difference between languages may be thus summarized.

I. Languages undergo decay, and, consequently, single words, and even whole families founded on certain roots, and, consequently, the roots themselves, may wholly disappear out of all languages. A few derivatives may, however, escape destruction, and thus preserve the root in one or more languages, while all trace of it may have passed away out of other languages. In this state the root would be obscured. Again, a group of words may disappear, with the exception of a few derivations, out of one or more languages, but may be preserved in several others, which would thus afford a key to the root of the derivations left. We could not give examples of the first kind, because we are not sufficiently acquainted with all roots and all languages to be able to say that any one root has *positively* perished, though it is probable that numbers of them have. We can give abundant examples of the last kind of loss, but one may suffice. Engl.—*Bridegroom;* Anglo-Saxon, *Brŷdguma;* Germ.—*Bräutigam;* old high German—*Brutigomo,* from Gothic—*Guma;* Anglo-Saxon —*Guma* = old high German—*Gomo;* Lat.—*Homo* = *man;* no simple word from the same root now existing in German, while in English we have the word *Groom.* Languages grow as well as decay; this growth is, however, chiefly upon the foundation of previous words, but there is no reason to the contrary, if we assume that new roots are sometimes created.

II. Two or more languages may have complete identity of roots and of a great many simple words, and even of derivatives, but these may have been modified in sound and in meaning. This may occur in either of the following ways:—

1. In sound merely; a root or word may, in accordance with certain phonetic laws, have assumed different forms of sound in different languages.

2. By the employment of the same root or word to symbolize different ideas.

3. In both ways; that is, the original word may have been phonetically modified and its original meaning changed.

4. The same object may get its name in different languages from different roots, all of which may exist in each language. Thus, one people may derive the word blue from the colour of a lake, and another from the sky; or the word for horse from its swiftness, from its bearing burdens, or from the name of some place from whence they first obtained it, as is supposed to be the origin of the Hebrew word for that animal.

III. The same material or roots may have been subjected to different degrees or kinds of grammatical organization.

Character of phonetic modifications.

It is unnecessary just now to say anything further upon the first causes of differences between languages, the loss or gain of roots; and we shall accordingly proceed to consider the second category of causes, the most important among which, and perhaps of all causes, are phonetic modifications. Each nation, from causes not hitherto determined, use certain simple and mixed sounds in preference to others; and as different classes of articulate sounds exercise different muscles, the employment of particular sounds will help to strengthen certain muscles. On the other hand, those which would act in the production of the unused sounds, not being exercised in the same way, the faculty for producing those unused sounds will be weakened or even altogether lost. This difficulty of pronouncing foreign sounds may be still further increased by the unequal development of one of the muscles required for its production, by its constant use in pronouncing some other sound. Hence, if one language borrows a word from another, it must modify it more or less, and even to such an extent as to render it scarcely recognizable, if it contains sounds or combinations of sounds which do not exist in the language into which it is introduced.

Again, if we recollect the classification of consonants according to the organs which produce them and the manner of their production, we can understand how consonants cannot be joined with one another at random to form a syllable; or in other words, those consonants alone can be fully and purely sounded in succession as parts of one syllable, which are produced by organs and muscles which can be rapidly articulated or moved one after the other. And further, the final consonant of one syllable influences the initial one of the next in a similar manner. If the articulating organs be unable to produce the sounds in succession, they will substitute some other sound which will be naturally formed in the attempt. Even the vowel sound which accompanies certain consonants or combinations of consonants, is not an indifferent matter, and consequently it also may suffer change. The character of the modifications and substitutions which take place in this way depends upon the phonetic character of each language; or in other words, each language has phonetic laws of change of its own. From the study of these we may make a general code of phonetic laws which would enable us to include all the possible ways in which words may be phonetically modified within a limited number of categories. The more important of these general laws may be briefly summarized as follows:—

Ways in which languages

Languages change phonetically in three ways—1. by exchange of one sound for another; 2. by the addition, loss, or change of position of sound; 3. by contraction. We shall take each of these processes and examine it somewhat more in detail.

change phonetically.

I. The exchange of sounds may also take place in three ways —1. Without the apparent influence of other sounds or of the phonetic elements of the word generally, that is, where they are not the cause of the change, though they may exert a modifying influence upon the manner in which it is exerted; 2. by the action of neighbouring sounds and syllables, influence of the phonetic material—assimilation, dissimilation, and influence of phonetic equilibrium, law of compensation; 3. influence of accent.

By change of vowels.

1. *Without influence of other sounds: (a) by a change of vowels*, which usually takes place from *a*, *i*, *u*, into *e* and *o*, and of *a* into *i* and *u;* a reverse change is not considered to occur; the following example shows the kind of interchange through the whole vowel scale: German—*lache*, Italian—*lago;* English—*lake* (a=e); Latin—*lix;* Irish—*lough;* Vendish—*luza.* *(b)* by an exchange of vowels with consonants, such as the change of *i* and *u* into the half-vowels *j* and *v*, and the reverse. Another example of the same kind is the affinity which subsists in some languages between *u* and *l*, which is displayed in two ways—first, *l* becomes *u*, but it must be preceded by a vowel, for example, Latin—*collum* becomes French *cou;* secondly, a vowel preceding *l* is changed into *u;* example, Gr., ἕλκος; Latin, *ulcus.* The Latin *l* becomes *i* in Italian when it occurs between a mute and a vowel. Example, *planus*, *piano;* *clarus*, *chiaro.*

By interchange of consonants.

(*b*) *Interchange of consonants.* Consonants can only interchange when they are related to each other. This relationship is of two kinds, *homorganic*, or those produced by the same organs, such as dentals; and *homogeneous*, or those produced by the same kind of action, such as liquids, etc. This relationship is crosswise, as will be understood from what we have said on the classification of consonants; that is, two consonants may happen to be homogeneous and homorganic at the same time; as, for instance, *l* and *n:* this is, however, not common, and even in the example *l* is an oral liquid, while *n* is nasal. In accordance with this distinction, consonantal interchange may be included under two categories: 1. The interchange between homogeneous consonants, of which numerous examples might be given, between the half vowels, spirants, and *h*—Ex.: old High German, *ahsala;* middle High German, *ahsel;* modern German, *achsel;* Latin, *filum;* Spanish, *hilo;* between the liquids, such as *l* and *r*—Ex.: Lat.—*Peregrinus;* Ital.—*pelegrino;* French—*pélerin;* *l* and *n*—Ex.: Lat.—*apostolus;* French—*apôtre*, etc.; between mediæ interchange is very rare; between tenues, and finally between aspirates and spirants. 2. Interchange between homorganic consonants. Of this kind are (*a*) the interchange of continuous and explosive consonants of the same organic kind, such as *v* and *b*—Ex.: Lat., *vervex;* Middle Latin, *berbix;* French, *brebris;* *j* and *g*—Ex: German, *Gemse;* Polish, *Giemza;* *h*, *ch* (χ), and *g*—Ex.: Gothic, *Guma;* Old High German, *gomo (komo);* Latin, *homo;*

d and *t* into *s*—Ex.: Greek, ῥόδον; Latin *Rosa; l* and *d; m, b, p*—Ex.: Gothic, *stibna;* old English, *stempne;* old Saxon, *stemna;* German, *stimme.* 2. The interchange of the homorganic labial-mutes *b, p,* etc.; dental, *d, t, th,* etc.; palatal, *g, k,* etc. Interchanges of this kind between homorganic mutes are so common that every one can suggest an example. Connected with the interchange of homorganic mutes, we may mention the remarkable historical interchange which has been discovered among the Indo-European languages, and which exhibits a perfect circular movement from one articulation stage to another, in accordance with the law of *transposition of sounds* (in German, *Lautverschiebung)* discovered by Jacob Grimm.[21] The Greek, Latin, and Sanscrit form one stage; the Gothic, Old Saxon, Anglo-Saxon, the Scandinavian languages, and the Lower German, the second; the old High German, the third stage. According to these successive stages, each of the nine mutes has been shifted forward in the direction in which the sounds are naturally developed—that is, the labial, dental, and palatal mediæ pass into the corresponding tenues, the latter into aspirates, and aspirates into mediæ again, thus completing the circle.[22] The middle and modern High German have remained nearly at the third stage, or that of the old High German, with, however, an increasing tendency towards a retrograde movement, that is, to soften the hard consonants, the former movement being a passage from soft to hard sounds.

Grimm's law of transposition.

The following table will help to render this very remarkable law more intelligible. The letters are arranged in three *homorganic* categories of labials, dentals, and palatals. The first column in each division serves to show to what homogeneous category the letters in the division belong. The second column gives the three Greek mutes belonging to each homorganic division; the third, the corresponding ones in Gothic; and the fourth, in old High German. Thus *b* in Greek corresponds to *p* in Gothic and to *f* in German, while *ph* in Greek is represented by *b* in Gothic and *p* in German—that is, the Greek mediæ become Gothic tenuis and German aspirates, etc. If we take any given letter in any of the languages named, we may, by this table, find the corresponding letters in any of the others; thus, *t* in old High German corresponds to Gothic *d*, etc.

		Labials.					Dentals.					Palatals.		
		Greek.	Gothic.	Old H. German.			Greek.	Gothic.	Old H. German.			Greek.	Gothic.	Old H. German.
Mediæ	*b*	*b*	*p*	*f*	Mediæ	*a*	*d*	t	th	Mediæ	*g*	*g*	*k*	*kh*
Tenuis	*p*	*p*	*f*	*b*	Tenuis	*t*	*t*	th	d	Tenuis	*k*	*k*	*kh*	*g*
Aspirate	ph f	*ph*	*b*	*p*	Aspirate	*th*	*th*	d	t	Aspirate	*kh*	*kh*	*g*	*k*

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[21] Deutsche Grammatik, I. S. 581.

[22] See J. Grimm, Geschichte d. Deutschen Sprache, S. 393; also Heyse, Sprachwissenschaft, S. 306.

2. *Under the Influence of Neighbouring Sounds.* Changes of this kind may be classed under two categories, 1. those depending upon the material *quality* of the sound; and 2. upon the quantity or equilibrium of the syllable. The first category may be further subdivided into, 1. assimilation of consonants and vowels; and 2. dissimilation.

Assimilation of consonants.

Assimilation is of two kinds, *homologous* and *analogous*, and may be either consonantal or vocal, progressive or retrogressive; generally it is the latter in the Indo-European languages, the speech going forward and anticipating, as it were, the following sound; but in the northern or Ural-Altaic languages, vocal assimilation is always progressive, the vowel of the affix being made dependent upon that of the root. 1. Homologous assimilation, or the assimilation of a liquid to a preceding liquid, or a labial, a preceding labial, and so on. Thus, in Greek σ assimilates ν in σὺν and πάλιν when they enter into combination; *e. g.*, σύσσιτοι, παλίσσυτος. Again, we have in Latin an example of a mute assimilating a mute when *ad*, *sub*, and *ob*, enter into combination; *e.g.*, *affinis*, *succedo*, *oppono*. This kind of assimilation is also common in the conversion of Latin words into Italian, thus: *dictus*=*detto*. The assimilating influence of l in the middle of a word upon a preceding ᴅ in Irish, may be referred to this category, thus: coᴅla sleep, is pronounced as if written colla. 2. Analogous assimilation, which is of two kinds; (*a*) homorganic, or the conversion of a consonant into another which belongs to the same organ as the following one, thus: *tam* gives *tandem;* that is, the labial *m* passes into the dental, to correspond to the dental *d;* French, *printemp*=Latin, *primum tempus;* Italian, *pronto*= Latin, *promptus*. (*b*) Homogeneous, or the conversion of a consonant into another which belongs to the same stage of articulation. This is the law in Greek for all combinations of two mutes; thus the soft labial β in τρίβω is hardened to the tenuis π, when in combination it is succeeded by the hard dental τ in τέτριπται. Again, the spirant *s* hardens the preceding media, *scribo—scripsi;* liquids, on the other hand, soften; thus, the hard *t* in *quatuor* is softened to *d* by the liquid *r* in *quadrupes*, etc. To this category belongs also the kind of assimilation called by Schleicher,[23] Zetacismus, which occurs in almost every language—namely, the action of *i* or *j* on a preceding *k* or *t* sound; in assimilating these it, as it were, squeezes them, and gives a hissing sound.[24] Assi-

Zetacismus.

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[23] Sprachvergleichende Untersuchungen, S. 33.

[24] The Hellenic substitution of the palatal sibilant ζ for the softened guttural and dental consonants of the ancient dialects, is of this kind. The English *g*, *j*, and *ch*, are also more or less the result of the same kind of action. The palatal sibilants resulting from Zetacismus are distinct from the original sibilants of the language, inasmuch as at the very period when the latter are fading into mere aspirations, or degenerating into semi-vowels, the process of substituting palatal sibilants may be in full activity.

milation extends also outside the limits of words, to the contiguous sounds of connected words, in the pronunciation of many peoples, and even to the written language, as was especially the case in Sanscrit.

Assimilation of vowels.

The assimilation of vowels differs so far from that of consonants, that, while the latter is almost invariably the result of contact of two sounds, in the former the vowel of a syllable acts upon that of the preceding syllable over the intermediate consonants. As examples of homologous assimilation, we may instance *nihil=ne hilum*, *consul=consilium.* The analogous assimilation of vowels may be described as the obscuring of the vowel of a preceding syllable, mixing with it another vowel sound. Of this kind is the remarkable progressive vowel assimilation in the Finnic-Tatarian or northern family of languages. According to the peculiar vocal harmony in these languages, a final *a*, *o*, *u*, becomes *ä*, *ö*, *ü*, if the root vowel be *ä*, *ö*, *ü*, and *vice versa.* The Irish rule of "Broad to broad, slender to slender", caol le caol aᵹuꞅ leaṫan le leaṫan, is very similar to the law of harmony just mentioned. In Irish the vowels are classified into broad (*a*, *o*, *u*,) and slender (*e*, *i*). Now, the rule is this, that a consonant or consonants should, in every written word, lie between either two broad or two slender vowels; or, in other words, if the vowel of a syllable be broad, the vowel of the next succeeding syllable should be broad; if a slender vowel preceded, a slender one should follow.

Dissimilation.

Dissimilation is the avoidance of the disagreeable repetition of like sounds by the conversion of homogeneous consonants into heterogeneous, and homorganic into heterorganic. For instance, the Greeks never commenced two succeeding syllables with aspirates; if in combination this happens, the first aspirate is converted into the tenuis homorganic with it. Indeed they appear to have avoided having the same consonant occur in two successive syllables. A remarkable example of dissimilation is afforded by the euphoneous interchange between the palatal liquid *r* and the dental one *l* in the Latin words ending in *aris* or *alis.* If the simple word or stock upon which the derivation is effected end in *r*, the termination will be *alis;* if in *l*, in *aris.* Examples: *singul*aris, *mur*alis, *Sol*aris. In English we have *purple*, from Latin *purpura; marble*—French, *marbre*, from Latin *marmor.*

Laws of Compensation.

Equilibrium of Sentences, or the Laws of Compensation.—In assimilation and dissimilation we have the establishment of euphony by means of a positive change of quality in the sounds themselves. In the laws of compensation we have a much more delicate method of attaining it in certain cases, by the relation between the quantity or length of the vowel sounds in connected syllables. Vowel changes of this kind may be purely phonetic, or, without having any positive grammatical value, may affect the symbolic meaning of a syllable by giving it phonetic preëminence.

The effect may be produced in two ways, by strengthening the vowel sounds, or by weakening them. The former consists in the diphthonging or lengthening of the short root vowels ;[25] the latter in the weakening of the stock vowel when it is increased by reduplication or prefix. Thus in Latin, *ă* becomes *ĭ* in open syllables, and *e* in closed ones ; *facio*, *efficio; annus*, *perennis.* In certain cases *a* passes into *u; ĕ* into *ĭ; ae* into *ī; au* into *ū; ō* into *ĭ; ū* into *ĕ*, etc. ; some of these changes being common to a great many languages, while others are peculiar to one.

Influence of accent.

3. *Under the influence of accent.*—The relative importance of this element of phonetic change depends upon the circumstance of its being fixed or variable. In Greek and Latin it was variable, and followed or depended upon the number of syllables in the word, or the quantity, which was almost always invariable. In modern languages there is a gradual tendency to make words purely symbolic, and hence in some of them accent is employed not only as a means for obtaining pure euphony, but to express intellectual differences, as a kind of delicate substitute for inflexions cast off. In such cases it overrides all other phonetic relations, altering the pronunciation of both toned and untoned syllables. Thus, for example, in German the tone or accent is quite invariable, always maintaining its position on the root or stock syllable ; such toned or accented syllables have their short vowels lengthened, or the following consonant doubled ; the vowels in the unaccented syllables being weakened or even volatilized altogether.

II. Augmentation, Retrenchment, Metathesis.—These phonetic means of change are presented to us under two aspects, either in their evident or historical form, as they have been presented to us in the gradual change of a given language in the course of time, or in the contrast of allied languages or dialects of the same stock, or as the expression of the assumed methods according to which grammarians suppose certain phonetic changes to have occurred either in the formation of the simple words or inflexions.

Augmentation.

Augmentation is applied to the addition of meaningless sounds to words in order to establish euphony, and takes place either by (*a*) Prosthesis or Prothesis, or the prefixing of a letter: thus Lat., *spiritus* ; French, *esprit.* It may be a consonant as well as a vowel. Anglo-Saxon, *meltan* (English—*melt*) gives English *smelt*, old German *smeltan*, modern German *schmelzen.* (*b*) Epithesis, or augmentation by a final letter, such as the ν of the third person singular in Greek, τέτυφεν; (*c*) Epenthesis, or augmentation by interpolation of sounds in the interior of the word. Example, of a consonant, Lat. *domitare*—French, *dompter;* of a vowel—Gr. Ἀσκληπιός —Lat. *Æsculapius.*

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[25] This is the Guna and Wriddhi of Sanscrit grammarians: the former consists in adding an *ă* before the vowel, so that from *i* or *u* *ē* or *ō* is obtained. Wriddhi consists in the use of *ă* in the same way, so that *ā* before *i* gives *ai ; ā* before *u* gives au. Heyse Sprachwissenschaft, S. 316.

Retrenchment.

Retrenchment is rarely employed to produce euphony, but rather for brevity, and is one of the principal causes of the difficulty of discovering the roots in some languages, as in French. It takes place either by (*a*) Aphæresis, or the retrenchment of a vowel or consonant in the first syllable. Example, Lat. *extraneus*, Ital. *estraneo;* French, *é(s)tranger*, Engl. *stranger*. The French word is an example of the retrenchment of a consonant, the English of a vowel; (*b*) Apokope, or the cutting off final vowels and consonants. The latter is common in Greek, such, for example, as the dropping of final mutes; the former is not, but very frequent in other languages. Sometimes the whole syllable is cut off, Latin, *Amicus*—French, *Ami.* (*c*) Retrenchment in the interior of a word, which may be, 1. elision, or the dropping of one vowel when two come together, as *ne—unquam* = *nunquam;* 2. syncope, or the dropping of a vowel occurring between two consonants. Example, πατήρ—πατρός; Lat. *valide—valde.* Sometimes it causes the melting of two words. Example, *do not*, *do'nt;* (*c*) dropping of a consonant or of a whole syllable or eclipsis. When this takes place in the case of a consonant and two vowels, the latter are drawn together, and a long vowel produced, if the two vowels be alike, or a diphthong, if they be different. We need not give examples of this kind of change, as they are abundant in every language, and in most cases the rules vary with the language.

Metathesis.

Metathesis, or the reversal or changing about of the position of a sound with respect to the other sounds of a word. It is one of the commonest and most important methods of changing the appearance of words, and producing difference between allied languages. Examples: Latin, *pro;* Spanish, *por;* French, *pour;* Gothic, *brinnan*, *brennan;* Anglo-Saxon, *birnan;* English, *burn;* Anglo-Saxon, *thridda;* English, *third.* The tendency in the modern languages is to transfer the consonant after the vowel, as in the examples given; but in the Slavonic dialects the tendency is the reverse, at least in the case of the liquids.

Contraction.

III. Contraction is the combination or fusion of two or more vowels belonging to different syllables, to a single mixed vowel or diphthong. In some languages this is effected only for euphony, in others its object is brevity. As the simple vowels are all preserved in the compound one, and are not lost, as in the case of actual retrenchment, the effect of this method of change is not nearly so destructive of the organic form of the language as those already mentioned. Contraction may be imperfect or perfect; the former is only employed in the pronunciation, the latter being also employed in writing. Imperfect contraction is of two kinds: Synizesis, or the combination of two vowels in pronunciation to a diphthong; and Synalœpha, or the melting of two vowels to one mixed vowel, which needs not necessarily be long. They are both temporary means of helping rhythm, and their only permanent effect is dependent upon what the early rhythmical ballads of a people may have upon its ultimate pronunciation.

Perfect contraction is of two kinds: contraction properly so called (*συναίρεσις*), which takes place within a word, or between two separate words, or crasis which is almost confined to Greek.

All the chief letter-changes come under the foregoing categories.

What the discovery of the peculiar phonetic laws of each language enables us to do.

All, or nearly all, possible modes of word forming and letter changing, which could exist in any language, may, we believe, be included under some one or more of the categories mentioned in the preceding abstract. If the changes of this kind, which every language admits of, be determined, the comparative philologist is also able to discover the special phonetic laws which belong to each language. Having discovered these, he may now proceed to analyze the words of any language, decompose the compound ones into their component ones, strip the derivatives from a common stock word of their inflexional elements, and unclothe the stock itself so as to obtain the naked root: he may even in many cases discover the roots of the inflexional elements themselves. Again, he may proceed synthetically as well as analytically: knowing the modification which a simple word or root would undergo on being subjected to the action of the peculiar phonetic laws of a language, or of a series of languages, singly or in succession, he may test the accuracy of his analytical results, by building upon one of his roots all the words which it might form in accordance to the phonetic and formalistic or grammatical laws of a given language, and then see how far his backword process accords with the actual words in that language. This synthetical test has never, as it ought to have been, applied to the whole series of roots of a family of languages, and the artificial materials for a lexicon thus formed, compared with those which the natural growth of the language had evolved.

Etymological researches not based upon phonetic laws, of no value.

It must be evident that any attempt at etymological investigation, not founded on a knowledge of the phonetic laws of languages, must be perfectly barren in result. We admit that the results hitherto obtained by the phonetic system are not above suspicion; nay, more, we confess that acknowledged adepts in the processes of letter changing have arrived at the strangest results, such even as the wildest etymological guesses of the old school of philologists could scarcely rival certainly never excel. All this merely proves that a good instrument has been badly applied, and that philology is yet in its infancy as an inductive science.

Difference between languages in grammatical organization.

Having disposed of the phonetic laws, the basis of all branches of comparative grammar, we can now address ourselves to the last element of difference between languages—grammatical organization. The special object which we have in view in this essay dispenses us from dwelling with the same detail upon this element of difference that we did upon the phonetic one. It would not, indeed, be necessary in any case, inasmuch as every one is more or less acquainted with the elements of grammar, while the principles of letter-changes are comparatively but little known. When we speak of grammatical organization, we mean it chiefly in reference to the formation of grammatical words (adjectives, adverbs), inflexions, etc.; because, strictly speaking, all we have said about roots and words belongs to the subject of grammar, just as much as anything we shall hereafter say; but the distinction, without being logical, is convenient. We shall have to make a few observations on the classification of languages in connection with the Indo-European and Finn Hypotheses, and this will offer us an opportunity of communicating as much information on this part of comparative grammar as will suit the purpose we have in view.

Classification indispensable.

Bacon's aphorism, "*Citius emergit veritas ex errore quam ex confusione*", however we may be disposed to doubt of its truth universally, is quite applicable to the case of sciences which deal with a multitude of objects or facts. Better some classification, even though erroneous, than none at all, because we may safely say that one of the greatest progressive steps which an infant science can make is the framing of some classification. In the infancy of science the classification must needs be artificial, because the affinities linking the objects or facts cannot be known, much less can their order or relative value. One of the uses, indeed, of a system of classification, is to enable affinities to be discovered. The most artificial classification ever proposed contained some elements of a natural one; but a perfectly natural one can only be framed at a very advanced stage of the science. There can be no doubt then that there is some truth, indeed much, in the recent classifications of languages proposed by several distinguished German philologists; nevertheless, they are but temporary scaffolding, and should never be looked upon in any other light. Of all those which have been proposed, that of Pott appears to present most advantages, with one exception, which we shall hereafter refer to, than any of the others. This classification may be thus summarized: 1. *Isolating languages*, or those in which the matter or chief idea, and the form, or secondary idea, derivative or flexional element, still remain perfectly separated. 2. *Agglutinating languages*, wherein matter and form adhere together, but scarcely more than externally. 3. *True inflexional amalgamating languages*, in which the matter and form are so intimately blended that both fuse into an indecomposable unity. The first class is represented by the Chinese and Indo-Chinese languages; the second, by the Finnish, Turkish, Mongolian, and other languages grouped together in accordance with the Finn hypothesis; the third, by the Semitic, and still more so by the Indo-European languages. The latter is the proper normal type; the first two are below the normal; but there are others again which Pott considers to exceed the normal, namely, the American; and accordingly he makes a fourth class of them;—4. The transnormal or *incorporating languages*.

Pott's classification.

F. Schlegel's.

F. Schlegel, who was one of the first to make a general classification of languages, divided[26] them into three principal classes: *flexionless*, *affixing*, and *inflecting* languages. A. W. Schlegel[27] adopted his brother's classification, but subdivided the inflecting languages into *synthetical*, or those whose inflexions are chiefly formed by additions to the root or stock word, and *analytical*, or those which can also make internal phonetic changes in the root or stock word perform the functions of inflections. The Indo-European represent the synthetical languages; the Semitic (Hebrew, etc), the analytical. Bopp[28] has made another classification, in which he starts from the mechanism of the languages—that is, the means by which their grammar is formed, and accordingly distinguishes the following classes: 1. Languages with monosyllabic roots, without the power of combination, and, therefore, without organization, without grammar; of which the

A. W. Schlegel's.

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[26] See his celebrated work, "Ueber die Sprache und Weisheit der Inder".

[27] "Observations sur la langue et la literature Provençales".

[28] Vergleichende Grammatik, s. 112.

Chinese is the type. 2. Languages with monosyllabic roots, but capable of combination, and developing their organization or grammar almost wholly in this way; of which Sanscrit, Greek, and all other languages (whether agglutinating or amalgamating), with the exception of, 3. the Semitic languages, which produce their grammatical forms not only by combination, but also by internal change in the root itself. W. v. Humboldt,[29] though making the external form or grammatical structure of languages the basis of his classification, seems to have been influenced also by what we might term the comparative psychological character of languages. He takes two extreme opposite types—the Chinese and Sanscrit (Indo-European) languages, the former having no phonetic expressions whatever for grammatical differences, while the latter express them in the most perfect manner by true inflections. All other languages lie between these extremes, and admit, in general, of being only negatively characterized; while, on the one hand, they are capable of expressing some grammatical relations, they do not possess true inflections; hence they can only be included together in one class upon very general and indefinite grounds. The grammatical differences in this very loosely formed class are, however, distinguished, so far as external form or material expression is concerned, very clearly and sharply, by particles or *formal* words, which are themselves either complete words or can be directly referred to such, and, consequently, have an independent meaning. But, on the other hand, they do not possess any invariable, inherent *formalistic* or grammatical difference between noun and verb, so that it often happens that any word may be used as a verb or noun indifferently. This would show, in accordance with what we have already said upon the subject of roots, that the words in these languages have not yet lost the intrinsic character of primitive roots, that is, are rather materials for nouns or verbs than either of them properly. Humboldt divides this class of languages into two groups, according to the mode in which the particles are employed: (*a*) *Particle languages*, properly so called, which do not characterize the verb by any external form, like the Indo-Chinese and the Polynesian languages. To this class he also

W. von Humboldt's.

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[29] See the Introduction to his great work, "Die Kawi Sprache".

adds the Mandchu and Mongolian, but this, we believe, he did upon imperfect data. 2. *Agglutinating languages*, which characterize the verb more or less perfectly by pronominal suffixes, shortened or modified in form. In accordance with this classification, the Chinese, as being more consequent, would stand higher than the whole class, which is characterized by a want of true logical consequence, the grammatical spirit having been obscured by mixing the material and formal meaning together.

Steinthal's.

Steinthal[30] has proposed another classification not founded, like all the preceding ones, upon the external form or mechanism of the languages, but on the specifically different internal feeling or power of languages of different peoples, and the internal form of speech thereby developed. The fundamental idea of Steinthal's classification appears to involve the admission of several distinct races of men, while all the others are consistent with unity of race, or actually assume it.

Languages drop their inflexions.

Inflected languages have within historical times undergone a singular change, which has resulted in the production of what might be considered as a perfectly distinct class of languages. This change is the falling off of the inflections, or their incorporation in some instances with the body of the word, losing at the same time their inflectional value, the functions of the lost inflections being then fulfilled by separate words,—prepositions with substantives, and auxiliaries with verbs. The English, French, Italian, modern Greek, the Germanic, and other modern European languages, etc., are now in this condition. They also exhibit a great instability in the manner of expressing relations of time, that is, the tenses, and even in the employment of the conditional forms of verbs. Navratil,[31] for example, has drawn attention to a singular circumstance of this kind in some of the Sclavonic languages. They are especially distinguished from other languages by a distinction between verbs depending upon the duration of the action—that is, into imperfect verbs

Change which Sclavonic verbs are undergoing.

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[30] Die Classification der Sprachen dargestellt als die Entwicklung der Sprachidee; Berlin, 1850—and Die Entwicklung der Schrift. Nebst einem offenen Sendschreiben an Herrn—Prof. Pott., Berlin, 1852. We have not had an opportunity of seeing either of these works, and are consequently able to judge of them only from a few extracts in Böhtlingks "Ueber die Sprache der Jakuten. St. Petersburg, 1851", and a reference to them in Heyse's "Die Sprachwissenschaft".

[31] Beitrag zum Studium des Slavischen Zeitwortes aller Dialekte Wien, 1856.

(*verba imperfectiva),* which express imperfect action, and perfect verbs (*verba perfectiva),* which express finished, completed action. By means of this distinction the Sclavonic dialects are able to express by a single form an action once performed, or the repetition of individual actions, or the action as a whole, and thus gain in precision and shortness of expression. Logically speaking, the perfect verb can have no present indicative; the imperfect verb, on the other hand, expressing action in process, can alone have a true present tense. Now, the change alluded to is the use of the present indicative of the perfect verb to express the true present. The effect of this tendency is to obliterate the imperfect verbs altogether. Such changes are more marked and rapid in the dialects of mixed peoples.

It may be useful here to point out some of the more prominent peculiarities of each of the great families into which philologists are disposed to divide languages. And we may observe, that these divisions exhibit in some cases remarkable coincidences with the geographical divisions of continents.

Development of alphabetic writing.

Alphabetic writing, as Dr. Donaldson has observed, was not invented by one effort. It was the result of a series of successive improvements. The first effort at assisting the memory must have been a rude drawing of the object; but such drawing must have had from the outset more or less symbolic meaning, as representing a quality or an action; for example, a rude outline of a horse, swiftness. It then became ideographic, the idea being directly suggested by the picture. Such was the Egyptian picture-writing in its earliest stage. For, as Champollion's important discovery shows, these ideographic symbols very soon became phonographic; the latter element never, however, becoming predominant. Out of the Egyptian ideographic writing was evolved the purely phonographic Hebrew letter alphabet, which was probably the parent of all other letter alphabets invented. In China the process of evolution was different. Instead of ideographic symbols, when they lost the power of pictorial representation, becoming phonographic symbols, as the Egyptian did, they merely became purely abstract symbols, like numerals (as Latham calls them, rhæmatographic), whose combinations expressed complex ideas, without any reference to the form of objects. In Chinese there are about 200 such simple signs, which have been derived originally from pictures of objects; out of these some 40,000 to 50,000 combinations can be made (the Imperial Dictionary contains about 33,000). The Chinese ideographic symbols have also their phonographic derivative in the Japanese; but this is a syllable alphabet, and not a letter one. Now Chinese writing expresses perfectly the character of the language; the monosyllabic roots are, in truth, abstract rhæmatographic sounds, which have no separate special meaning, and only acquire it in combination.

Accentuation in monosyllabic languages.

A monosyllabic language cannot have the syllabic accentuation of polysyllabic languages; but, in lieu of it, the Chinese has a very peculiar syllable tone, which belongs more to the character of the idea symbolized than to the sound itself, and is, consequently, of importance for the meaning of the word. This accent is not a mere emphasis, but a positive rise and fall of the voice, productive of a kind of musical intonation. This circumstance is of considerable ethnological importance, inasmuch as it seems very probable that accent was originally in all languages a musical intonation of this kind. Very recently, indeed, Weil and Benlöw[32] have endeavoured to prove that this was the case in Sanscrit and Greek, and, to a certain extent, in Latin also, and consequently in the mother-tongue of the Indo-European languages. We shall have occasion to refer to this subject again.

Character of American languages.

While the Chinese is characteristically monosyllabic, the American languages are apparently polysyllabic. The elements of a sentence, which in the Chinese are placed side by side without combination, are phonetically fused in the American languages, so as to become one word. As they have not attained a single trace of inflexions, or any more grammatical organization than the Chinese, they are polysynthetical rather than polysyllabic, and ought, strictly speaking, be classed with the Indo-Chinese family. The difference between them and the Chinese is more apparent than real, or, as Steinthal has well observed, purely morphological.[33] William von Humboldt[34] has termed one of them, the Mexican, *incorporating*, because it places the object between the subject and verb, as for examples—*ni-qua*, I eat; *ni-naca-qua*, I flesh eat; *ni-maca*, I give; *ni-te-tla-maca*, I-some-one-something-give. The close and striking affinity, or rather the absence of all intrinsic difference, between the American and Chinese languages, becomes remarkably evident, as Heyse observes, when, in Mexican, the elements of a sentence are too numerous to be fused into one word. In this case they fall asunder, and stand beside one another as indifferently as in Chinese; as the following example, from the work of Humboldt, already quoted, shows:—*ni-c-tschihui-eia in no-piltzen ce calli*=I-it make-for the my-son a house=I make for my son a house. Pott applied Humboldt's term *incorporating*, as we have seen, to the whole American languages, and made them a distinct family. While he considers the Chinese under the normal, he makes the American transnormal; it is difficult to understand what he means by this term; because the American languages certainly never passed beyond the monosyllabic stage in the direction of the normal type. Future researches will undoubtedly show that the American languages only form a subdivision of the Indo-Chinese family; that is, that they belong to the family of monosyllabic languages of which the Chinese is the highest type, and which includes the Siamese and other languages of farther India.

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[32] Théorie Générale de l'Accentuation Latine.

[33] Die Classification der Sprachen. Quoted in Heyse's Sprachwissenschaft, S. 175.

[43] Die Kawi Sprache=Einleitung.

Character of Malayan.

The Malayan is another family intimately connected with the Chinese. The languages of this family are spread over the Phillippine Islands, Sumatra, Java, Borneo, Celebes, Madagascar, and the peninsula of Malacca, forming the western branch, or Malay Proper, and the Polynesian Islands, or the eastern branch. The words are monosyllabic, and consist of the naked roots, inasmuch as any word may be used indifferently, as substantive, adjective, or verb. The grammatical relations in the eastern branch, as in the Indo-Chinese, are expressed by the position of the words, and by separate particles; or, in other words, it has no grammar. The Malay, in the stricter sense, without having a true grammar, exhibits a tendency to form words by the addition of prefixes, affixes, etc. Considering Chinese as the type, we have one great family of languages, consisting of three great groups, the Indo-Chinese, the American, and the Malay-Polynesian. The latter, it may be remarked, is very much mixed up with Sanscrit elements in those places geographically situate near India; this is the case with the Kawi, or poetical language of Java. It was this intimate mixture that led Bopp to consider the Malayan languages as disintegrated Sanscrit dialects. One of the greatest problems in philology would unquestionably be the investigation of the roots of all the languages of the three groups here mentioned, with the view of establishing their identity. The time is, however, distant when a solution of so vast a problem can be hoped for.

Northern or Altaic-Uralian family.

Conterminous, northward and westward, with the last named great family, come a multitude of languages spoken by nations, which occupy the whole of central and northern Asia, from the Pacific to Europe, and even part of Europe itself. These languages exhibit sufficient affinities to entitle philologists to connect them together into one family. The limits of an article, and the object we have in view, forbid us to enter into any details as to the nature of those affinities; but as this is the northern family, already mentioned in connection with the Finn hypothesis, we may find it useful, subsequently, to note somewhat more specially than in the case of the last group of families, the kind of general affinities by which the members of the family are linked together.

Progressive grammatical development in going from east to west.

This family exhibits a remarkable development in grammatical organization as we proceed from east to west. The Mandchu, which is conterminous with the Chinese, exhibits the first development of the agglutinating stage of languages, but was congealed in its very infancy; while in Finnish and Hungarian, the most extreme western members, we have two languages which approach so closely to the European type, that many are disposed to take them, especially Finnish, out of the class altogether, and join them to the Indo-European. The family thus naturally divides itself into two divisions:—the eastern—Mandchu (Tungus) and Mongolian; the western—Turkish and Finnish languages. Between them come the Samojede group, which in some respects belongs to the first. The language of the first division can scarcely be said to have any true grammatical categories, there being frequently no absolute distinction between adjectives and verbs. Thus, in Samojede, the adjective, when used as an attribute, has the meaning of a noun, as *sawa jâle*, a good day; but if it be used as a predicate, it acquires a verbal character, as the conjunction is at the same time contained in it, as *jâleda sawa*, the day is good. It may also get an adverbial significance. Similarly, the substantive may be a nominal or verbal stock at the same time,

Family divides itself into two divisions.

Character of first division.

This absence of distinct grammatical categories goes so far in the Samojede, that a noun may be both declined and conjugated, the latter not extending, however, beyond the indicative mood; still in this mood the personal suffixes of the noun and verb are not completely different. The verbal suffixes can not only be affixed to the nominative, but even to the other cases. Possessive suffixes may be added to nouns, as *anou*, my boat; but in some dialects this may be likewise added to verbs, so that the two kinds of suffixes are common to nouns and verbs, and no distinction, as in other languages, can consequently be founded on them. In the second division of languages there is, as above remarked, a much greater approach to the true inflexional character of the Indo-European languages; but, notwithstanding the really wonderful and highly poetical development of both Finnish and Hungarian, the peculiar and imperfect character of their original organization has never been fully overcome. No superfluity of forms, or delicate modes of expressing minute shades of difference of action, can ever counterbalance the want of this inner logical consequence, which can only be attained by an absolute separation of the grammatical categories. As examples of the existence of this kind of imperfection, even in Finnish and Hungarian, which are undoubtedly the most perfect languages of the family, we may mention that they have no true subjective and objective cases; the same word also often serves as noun or adjective. Finnish has a superlative degree, and both it and Hungarian a comparative; but they are wanting in all the other languages, and can only be expressed by particles and adverbs.

Character of second division.

We have not space to insist upon further grammatical imperfections, and shall therefore content ourselves with giving a few examples of the most characteristic resemblances which have been noted.

Assuming roots to be necessarily monosyllabic, we cannot help being struck with the general dissyllabic character of the simple words in the whole family. Even the foreign monosyllabic words, borrowed into Finnish for example, or the Chinese roots into Mongolian, are made dissyllabic by the addition of a rhythmical final vowel. Indeed the difference between the roots and simple words appears in all cases to consist in the clothing of the former with such a rhythmical vowel.

Rhythmical final vowel.

This dissyllabic character of the simple words is one of the circumstances which make Finnish, etc., tend so much to the trochaic rhythm. The root is inflexible throughout all the languages of the family, a peculiarity which distinguishes it in a marked manner from the Indo-European and Semitic families. It can neither have the vowel strengthened, interchanged, or subjected to metathesis; the only change of which it seems capable is the softening of a final consonant according to a certain law of harmony. There appear, however, to be some exceptions to this rule of root inflexibility in Lappish and Jurak-Samojede, and Böhtlingk has recently noticed the same circumstance in Jakutish. The root, on the other hand, influences all the suffixes.

Inflexibility of root.

In other languages accents appear to have a lengthening effect on vowels only; but in Finnish, Lappish, etc., the consonants are similarly affected, so that they help to protect the vowels from modification. This produces an equilibrium between the consonants and vowels, so that neither of them can be said to predominate. The heaping of consonants is thus avoided; for instance, in Finnish two consonants cannot begin or end a word. In pure Hungarian words also, two different consonants scarcely ever occur in the same syllable, and foreign words are often completely modified in accordance with this circumstance by the intercalation of a vowel between the consonants, thus—*Stephen;* Germ., *Stephan* becomes *István*, etc.[35] The same principle operates more or less in Mandchu, Mongolian, Turkish, and Samojede, especially as regards initial consonants, and, indeed, may be said to constitute a general characteristic of the entire family.

Action of accent upon consonants.

The most remarkable feature, however, of the northern family, is the peculiar law of vocal harmony which reigns throughout every member of the family. In these languages the vowels are divided into three classes: 1. hard (*majores*); 2. soft (*minores*); and 3. neutral (*mediæ*). To the first class belong *a*, *o*, *u*, to which in some languages *y* is also added; the second class contains the obscure or mixed vowels *ä*, *ö*, *ü*; *i*, and in some languages *e*, belong to the third class. Now the law of harmony is this: 1. If the root syllable of the word contains a hard

Laws of vocal harmony.

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[35] Die Grundzüge der Finnischen Sprache mit Rücksicht auf den Ural-Altaischen Sprachstamm. Von H. Kellgren, Berlin, 1847.

vowel, *a*, *o*, *u*, (*y*), the following syllables cannot have a soft vowel, *ä*, *ö*, *ü*; 2. in like manner hard vowels cannot follow soft ones; 3. the vowel *i* is neutral, and may be followed by either a hard or soft vowel; 4. this is also the case with *e* in the Finnish and Samojede languages.[36]

Dislike to prefixes.

The roots in the northern family form the first syllable of the word; or in other words there are no prefixes. This circumstance is in some degree opposed to the formation of compound words; but it is chiefly to the inflexibility of the root and the domination of the law of vocal harmony, that we must attribute the want of power in the languages of this family to form true compound words. They either use special words as a substitute for such compounds, or they seek to effect the object by different means. Thus in Finnish, instead of forming a true compound, one of the words is put in the genitive, as *puun latva*, the *tree's top*, instead of *tree-top*. One of the most characteristic distinctions between the northern languages and the Indo-European ones, is the circumstance that they have the same case suffixes in all numbers. The Northern Samojede dialects form an exception to this; they have different endings in different numbers, and in this respect approach therefore the Indo-European languages. The plural endings in several members of the family exhibit a great affinity. Thus in Finnish, Morduin, and Ostjak, it is *t;* in Mongolian it is also *t* or *ut* (*üt*); in Esthonian it is *d;* in Lappish, *h* (*k*); and Hungarian, *k;* in Tungus, *l.* In some others it is irregular: thus in Syrjænean, it is *jas;* Tcheremiss, *wylæ;* Turkish, *lar*. The affinity between genitive suffixes is still more striking, for as a general rule it is *n;* even the Mandchu ending *ni* or *i* can be scarcely considered an exception. No special affinity can be discovered between the other case-endings. In expressing the cases in plural, the root, in accordance with what we have said above, goes first, then the plural suffix, and lastly the case suffix; so that the plural suffix is intercalated between the latter and the root in converting the singular into the plural. A few examples will make this more intelligible, and at the same time show the character of the agglutinating principle. We shall select the Syrjænean word *mort=man*, the Osmanli word *Khatoun=lady*, and the Tungus word *bira=river*, so as to take our examples from

Plural endings.

Case suffixes.

Agglutination illustrated by declension of nouns.

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[36] Castrén—Grammatik der Samojedischen Sprachen. St. Petersburg, 1854, p. 23.

as widely different members of the family as possible. We need not, however, decline them fully, as that would occupy too much space, for there are no less than fifteen cases in Syrjænean, or rather sixteen, because there is a second ablative. We shall accordingly confine ourselves to two or three, and will separate for greater distictness the different suffixes by hyphens.

Syrjænean.

	Singular.	Plural.
Nominative,	mort,	mort-jas.
Genitive	mort, mort-län, mort-lys,	mort-jas. mort-jas-län. mort-jas-lys.
Accusative,	mort-äs,	mort-jas-äs.

Tungus.

	Singular.	Plural.
Nominative,	bira,	bira-l.
Genitive,	bira-ŋi,	bira-l-ŋi.
Dative-Locative,	bira-du,	bira-l-du.

Osmanli.

	Singular.	Plural.
Nominative,	Khatoun,	Khatoun-ler.
Genitive,	Khatoun-uñ,	Khatoun-ler-uñ.
Dative,	Khatoun-gha,	Khatoun-ler-gha.

Grammatical changes of verbs made by suffixes.

Nothing, however, shows the character of a language better than the verb. The grammatical relations, such as mood, tense, pronominal endings, etc., which in other languages are denoted by lengthening, interchange, etc., of the root vowel, by prepositions, or modifying particles, must be expressed in the northern languages by the successive addition of suffixes, which are subjected to the proper laws of euphony. The cause of this is the aversion of all the languages to prepositions, and the inflexibility of the root. In the most developed languages of the family,—the Finnish, Hungarian, and Turkish,—the verb possesses an extraordinary power of denoting modifications of action, and relations of the verb to the subject and predicate. The words formed in this fashion, though sometimes unwieldy, possess much poetical expression, and enable the freest scope to be given to the most exuberant fancy.

Order of attachment of suffixes.

In the conjugation of the verbs, the stock, or simple verb, formed by the clothing of the root, and which is most generally to be found in the second person singular, imperative mood, of the intransitive form of the verb, is placed first, as in the declension of the nouns. This is followed by the suffix, denoting the class of verb, as, diminutive, frequentative, inchoative, etc.; next comes the suffix of form, that is, of active, passive, intransitive; after this, the suffix of mood; and finally, the personal suffixes. In Finnish, the personal endings are the same for all forms and modes, with the exception of the verb *ole* (be), and the manner of conjugating the same. Foreign influence has affected the Hungarian conjugation, and rendered it much more complicated. In Mongolian, properly so called, the verb does not take personal endings; but in Burjætish there is no verbal form without them, although they may be dropt; it is only the third person singular and plural, which, properly speaking, can be said to want endings, but they are more or less irregular. In Tungus also, the third person singular and plural are used without suffixes; the personal endings of the present and other tenses are a little different, but in the imperative, they are very irregular. It is probable that in all the Samojede dialects, the personal endings were formerly the same in all the classes, forms, etc., of the verb; but they have suffered modifications, and are not now alike. According to Castrén, the ending for the first person was *m*, which would agree with the Lappish, Syrjænean, Tcheremiss, Ostjak, Hungarian, Turkish, and also Finnish, in which it is *n (ni)*, but evidently by interchange with *m*. In Tungus, we also find *m* as an ending in the first person singular.

Personal endings.

It may be interesting to give one example of the manner in which the verbal suffixes are added in agglutinating languages. We shall select the Turkish verb *sev*, love; participle, *sev-er*, loving; infinitive, *sev-mek*, to love; present indicative, *sev-er-i-m*, I love (literally, "loving am I"). The present indicative is thus formed from the participle, *sev-er*, and *i-m*, the first person singular of the imperfect verb *i-mek (mek*, in the Turkish, is the suffix of the infinitive), to be; which is confined to the Ottoman dialect. This infinitive appears not to have been ever used;[37] *i-m* is formed from the root *i;* and the pronominal suffix *m*, in accordance with what we have mentioned above, that *m* was the suffix for the first person singular in the majority of the northern languages. The following gives the manner of forming the persons and numbers in the present indicative, and will serve to

Agglutination illustrated by conjugation of verbs.

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[37] Eclaircissements sur quelques Particularités des Langues Tatares et Finnoises, par F. L. O. Röhrig. Paris, 1845, p. 20.

show the principle upon which the other tenses are formed:—

	Singular.			Plural.	
1st per.,	sev-er-i-m	= loving am I.	1st per.,	sev-er-i-z	= loving are we.
2nd ,,	sev-er-sen	= loving thou.	2nd ,,	sev-er-siz	= loving ye.
3rd ,,	sev-er	= loving.	3rd ,,	sev-er-ler	= loving.

In the second person singular, the suffix is *sen*, thou; the third person singular has no personal suffix, giving us an example, in a comparatively highly developed language, of what we have stated respecting Burjætish and Tungus. The first person singular is regular, the suffix being formed from the root *i* (from *imek)*, and the soft *s*=*z* suffix of the first person plural; the second plural has *siz*=ye; and the third person plural has merely the simple nominal plural suffix. A still better example of the independence and want of adhesion of the suffixes of agglutinating languages, is afforded by the manner in which the different forms of the verb are produced by intercalated suffixes. Thus:—

Active,	Infinitive,	Simple,	Sev-mek,	to love.
	,,	Negative,	Sev-me-mek,	not to love,
	,,	Impossible,	Sev-èh-me-mek,	not able to love.
Transitive,	,,	Simple,	Sev-dur-mek,	to make love.
	,,	Negative,	Sev-dur-me-mek,	not to make love.
	,,	Impossible,	Sev-èh-dur-me-mek,	not able te make love.
Passive,	,,	Simple,	Sev-il-mek,	to be loved.
	,,	Negative,	Sev-il-me-mek,	not to be loved.
	,,	Impossible,	Sev-il-èh-me-mek,	not able to be loved.
	,,	Transitive of passive,	Sev-il-dur-mek,	to make that some one be loved.
Reflective,	,,	Simple,	Sev-in-mek,	to love oneself, to please oneself.
	,,	Negative,	Sev-in-me-mek,	not to love oneself.
	,,	Impossible,	Sev-in-èh-me-mek,	not able to love oneself.
	,,	Transitive of reflective,	Sev-in-dur-mek,	to make oneself to love.
	,,	Negative of preceding transitive,	Sev-in-dur-me-mek,	not to make oneself to love.
	,,	Impossible of same transitive,	Sev-in-der-èh-me-mek,	not able to make oneself to love.
Reciprocal,	,,	Simple,	Sev-ich-mek,	to love reciprocally.
	,,	Negative,	Sev-ich-me-mek,	not to love reciprocally.

Reciprocal, Infinitive,	Impossible,	Sev-ich-èh-me-mek,	not able to love reciprocally.
„	Passive of reciprocal,	Sev-ich-il-mek,	to be loved reciprocally.
„	Negative of preceding,	Sev-ich-il-me-mek,	not to be loved reciprocally.
„	Impossible of the same,	Sev-ich-èh-l-me-mek,	not able to be loved reciprocally.
„	Transitive of reciprocal,	Sev-ich-tur-mek,	to make oneself to love reciprocally.
„	Negative of the preceding,	Sev-ich-tur-me-mek,	not to make oneself to love reciprocally.
„	Impossible of the same,	Sev-ich tur-èh-me-mek,	not to be able to make oneself to love reciprocally.[38]

Resemblance between agglutinating and incorporating languages.

A verb *quasi*-inflected after this fashion, may grow to an extraordinary length, especially if the personal endings be added. There is, undoubtedly, considerable similarity between this system of agglutination, and the incorporating method of the American languages, the difference being chiefly in the circumstance that in the latter, even nouns (the object) are intercalated in the body of the verbal form, as in the examples given at page 86.

Semitic family.

There now only remain three families of languages to be noticed—namely, the African, the Semitic, and the Indo-European. The first is, in all probability, but a subordinate division of the second, in the same way that we have considered the American and Malayan as allied to the Chinese. In this respect the investigations of Professor Fr. Newman on the Berber languages are of great importance. With regard to the Semitic languages themselves, they are second only to the Indo-European in the perfection of their grammatical organization. Gesenius, Ewald, Schwartze, Lepsius, Fürst, Delitzsch, and Rödiger, have all laboured to establish an identity between the roots of the Semitic and Indo-European families; and this appears now to be generally admitted. There is a singular anomaly, however, in the Semitic roots; they consist, in many cases, of three consonants, and are, therefore, unpro-

Triliteral roots in Semitic languages.

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[38] Éléments de la Grammaire Turke, par P. Amédée Jaubert. 2me. Edit., Paris, 1833.

nounceable without the addition of a vowel; but such an addition immediately develops not a simple stock word, but a grammatical form. For example, analysis yields, as the root of the verb to kill, *ktl*, which is quite ideal; if we add *a*, *o*, etc., we get *ktal*, *ktol*, etc.; but these are no longer roots, but grammatical forms of the verb. The change of letter, which, in the Indo-European languages, is the chief means of forming words, is, on the other hand, in the Semitic ones, one of the most frequent means of inflecting. We may have occasion subsequently to refer to this anomaly in the Semitic roots; but as we shall have otherwise very little to do with this family, we will not devote further space to it.

Grammatical structure of Indo-European languages well known.

As every one must be sufficiently conversant with the characteristic grammatical organization of the Indo-European family of languages, of which Greek and Latin form examples in the fully inflected states, and English in the stage after the throwing off of those inflections, we propose to take for granted that our readers are already possessed of the kind of information relative to this family that we have endeavoured to briefly give about the northern one.

Languages belonging to Indo-European family.

We have now ended our proposed sketch of the principles upon which investigations in comparative philology are founded; and we may, accordingly, proceed to enumerate the members of the two families we have selected as examples, which have been grouped together in accordance with the results of such investigations. This list will be of great use hereafter, and hence it is that we propose to devote so much space to it.

Indo-European.—This family is divided into six groups:—1. *The Indian*, which includes the Sanscrit,

Sanscrit.

the oldest form of which is to be found in the religious books of the Hindoos—the Vedas. The classic Sanscrit, or the language of the Brahminical epic poems, the Ramayana and Mahabharata, etc., is newer, and already differs from the Veda Sanscrit in sound, verbal and grammatical construction. From these sprung the *Pali*,

Pali.

the language of the Buddhistic books of Ceylon and of India beyond the Ganges, and which, according to Lassen, must have been formed in India Proper 500 years before Christ; the *Prakrit*, or vulgar language, which occurs in the dramas along with pure Sanscrit, and existed fully 300 or 400 years before Christ. These are now all extinct; but a great number of languages derived from

Prakrit.

them (at least verbally, though not always grammatically) are still spoken in India. These are divided into five chief divisions, namely, Bengali, Hindi (the Mohammedan court dialect, mixed with Persian and Arabic words, is generally called Hindustânî), Rag'aputra (central India at Udajapur, etc.), Mahratta, and G'ât (in Sind, Peng'ab, etc.). These include about twenty-six different dialects, according to Lassen. The Gipsy language is also considered to be a barbarized Indian dialect.[39]

Modern languages of India.

Gipsy language.

The *Persian*, *Medo-Persian*, or *Arian group*,[40] which includes the old Persian, whose oldest records are the arrow-headed or Persepolitan inscriptions on stone from the time of Darius and Xerxes; the Zend, an old language, but younger than the last, and so called from the religious book of Zoroaster, the Zend Avesta (the living word). Its home is supposed to be Eastern Persia or Bactria. The Pehlvi, or more properly Huzvāresh, as found in the inscriptions of the first Sāsānidæ about A.D. 229, and which is impregnated with Semitic elements even more than modern Persian; the Pazend or Parsi (being called the former when written with Zend characters, and the latter when written with the Arabic characters), which was spoken in the time of the later Sāsānidæ, in the sixth and seventh centuries, until the conquest of Persia by the Kalif Omar. The preceding languages are now extinct, but the modern Persian has grown out of them, but mixed with many Arabic words from the influence of Mohammedenism. The other living languages of the Medo-Persian group are those of the Affghans; of the Kurds of Kurdistan; the Beluchi, of Beloochistan; the Tâg'îks, of Buchara. To these a great number of philologists—among others may be mentioned Bopp—are now disposed to add the Irôn or Ossetic of the Caucasus, while Schleicher considers that the Armenian has most affinity with this family.[41]

Old Persian.

Zend.

Pehlvi.

Pazend.

Affghan, etc.

Irôn and Armenian.

Latino-Greek group, called by Schleicher the Pelasgic family, understanding by the term Pelasgic the fundamental language from which both the Latin and Greek have been derived, includes the dead languages, Greek

Greek and Latin.

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[39] See Pott. Die Zigeuner in Europa und Asien, 2 Bde, 1844–45.

[40] *Ārja* Zend *Airja* is the name by which these people originally designated themselves. *Iran*, the name of Persia, is derived from this word; from hence is also derived the term Arian, sometimes applied to the whole Indo-European family.

[41] Schleicher Die Sprachen Europas, s. 131.

Romantic languages.

and Latin, and the modern languages, Italian, Wallachian, new Greek, Spanish, Portuguese, and French—many of these languages being mixed with a considerable element of other groups.

Litthuanian.

Lett.

Church Sclavonic.

Litthuano-Sclavonian group. The Litthuanian branch bears the same relation to the Sclavonic that the Latin does to the Greek—that is, it appears older. To the former belong Litthuanian Proper, or Prussic Litthuanian (to distinguish it from the Samogitic or Polish Litthuanian, which is less pure), the oldest of all the living languages of the Indo-European family, for it still retains the seven cases of the Sanscrit and the dual; the Prussian, usually called Old Prussian, spoken on the Baltic coast east of the Vistula, in the neighbourhood of Memel, up to about the end of the seventeenth century, but now extinct; the Lett, the popular language of Kurland, or Courland, and the greater part of Liefland—a language which is to the Litthuanian what the Italian is to the Latin. The Sclavonian branch, which is divided into two groups, in accordance with a separation which apparently took place some centuries after the Christian era,[42] into Antens and Sclaves. The Antic or south-eastern group includes in the first place the old Sclavonic church language, into which SS. Cyril[43] and Methodius, the apostles of the Bulgarians and Moravians, translated the gospels, epistles, and psalms, and other religious books, in the second half of the ninth century;[44] the new Bulgarian, which is very much degenerated; the Russian (Great, Little, and White Russian); the Illyrian, that is—*a*, the Serbian dialect, with Cyrilian alphabet, called Illyrian when the Latin alphabet is used; *b*, the Slovenic, to which the Vendish or Crainerish, the Carinthian, and Styrian belong.

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[42] This division is probably founded upon a passage of Procopius, Bello Goth. 2. III. c. 14:—"Formerly the Sclaves and Antens had only one name: both were called Σπόροι, I believe for this reason, because they are scattered in their villages (σποράδην)". The real origin of the name being, according to Dobrowsky and Schafarik, the word *Srbi*, the name they gave themselves, and from which our word Servian is obtained, and the still more correct German name Serben.

[43] SS. Constantine and Methodius were two brothers, natives of Thessalonica, a half-Sclavonic city of Macedonia, who lived about the middle of the ninth century. Constantine, or Cyril, as he was also named, was called from his learning the "philosopher". He became a monk early in life, his brother Methodius being a priest, and afterwards archbishop. They first preached to the Sclavonized Bulgarians, and in 861 Methodius baptized Boris, the Bulgarian king. With the view of furthering the conversion of the Sclavonic people, Cyril (probably assisted by his brother) set to work in 855 to make a Sclavic alphabet, and between that year and 862 the translations mentioned above appear to have been made. This new Sclavonic literature thus took its rise in the Greek Sclavonic countries, then passed into the Bulgarian countries, and finally into Moravia, where the gospel was also preached by the two brothers.

[44] Schleicher (Die Formenlehre der Kirchenslavishen Sprache, s. 28)

Russian.

Serbian.

The second group is the Slavinic or Western, and comprises—the Polish or Lechish, the Bohemian or Tchechish, the Sorbish or Serbish of Lusatia[45]

Polish, etc.

Germanic group,—the oldest known type of which is the Gothic of Ulfilas' translation of the Bible, made in the second half of the fourth century. Leaving out the Gothic, this family may be divided into three branches: 1. *Scandinavian*, comprising Swedish, Danish, Norwegian, and Islandic, the fundamental language being the Old Icelandic of the Edda and other Saga. 2. The Low German or *Niederdeutsche* dialects, comprising the *Low German* or Plattdeutsche, the oldest form being the old Saxon poem, *Heliand*, in alliterative verse, made, it is said, in the ninth century. This dialect had its own literature until 1662, when the last edition of the Bible in it was published. The Dutch and Flemish (or Vlamische); the extinct old Frisian and Anglo-Saxon, the basis of the English. 3. The upper or High German dialects, comprising the dialects of Southern Germany and of Eastern Switzerland. The old fundamental languages were the Fränkish or old High German, between the seventh and eleventh centuries, and the Schwabian or middle High German, between the twelfth and fourteenth centuries. Since then the new or modern High German literary language has been formed, but not altogether out of the High German, but by the aid also of the Low German upon the basis of the dialect of Upper Saxony. The most characteristic distinction between the upper or High German and the Lower or Platt German dialects is the change of the mutes, *p*, *t*, *k* in the latter into *f* (*pf*),

Gothic.

Scandinavian dialects.

Low German dialects.

High German dialects.

Difference between low and high German.

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thinks that the language of these translations was probably Old Bulgarian. But as the Bulgarians, properly so called, were not Sclaves, but belonged to the Uralian or Tchudic race, and came originally from the region called Great Bulgaria, between the Don and Volga, he must rather refer to the Sclaves who occupied the countries on the Danube before the arrival of the Bulgarians.

[45] Called Polabic, from *Po=on*, *Labe=Elbe*, that is, living on the Elbe, and includes, or did include, a number of races such as Verlets, and who occupied the districts between the Baltic, the Oder, and the Elbe, Lusatia, and the part of Saxony east of the Saale, and believed to have also occupied Holstein, Mecklenburg, Lauenburg, etc.

z, and *ch* in the former—a change which, in all probability, arises from the great Keltic element in the population of Upper Germany.

Irish, etc.

Keltic group,—the living languages of which are divided into two branches: 1. *Gaelic*, comprising the Erse or Irish, the Scotch Gaelic, Manx. 2. Cambrian or Kymric, comprising the Welsh, the Armoric of Bretagne (another dialect, the Cornish, died out about sixty years ago). As we hope that the Keltic language and literature will receive a large share of attention in this publication, we need not enter further into the character of the ancient languages of the group here.

Skipetar.

Skipetar.—In the part of modern Turkey in Europe, along the Adriatic coast, from opposite the Island of Corfu northwards, and to the westward of the Bulgarians, exists a people known as the Albanians, or as they are called by the Turks, Arnauts, a portion of whom speak a peculiar language—the Skipier or Skipetar. They are generally looked upon as the descendents of the ancient Illyrians, who formed one of an extensive family of allied nations, that in ancient times occupied the country lying along the east and north-east coast of the Adriatic and thence even into Asia Minor, and to which the Getae or Dacians, the Mœsians, the Macedonians, the Epirots in Europe, and the Lydians, Carians, Phrygians, etc., in Asia Minor are referred. This language has been unclassed, opinion leaning towards placing it in the Northern Family. According to Schleicher,[46] however, the Skipetar is Indo-European; its nearest affinities being with Greek, but much corrupted.

Languages belonging to northern family.

NORTHERN.[47]—This family consists of five well defined groups of languages, which most, if not all, philologists now admit to be so intimately connected as to constitute a distinct family and to have had a common stock language.

I. The *Finnic*, *Ugrian*, *Tchudic*, or *Uralian* group consists of four branches, each of which in turn comprises a number of languages, and these again of dialects:—1. Languages of the *Baltic Finns*,[48] comprising the Es-

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[46] Die Sprachen Europa's, S 138.

[47] This family has received a great number of names, according to the particular point of view under which it was studied, such as—the *Ural-Altaic, the Altaic, Finnish-Tatarian, Mongolian-Tatarian, North-Asiatic* or *Turanian*, etc.

‡ All the Baltic Finnish languages are very similar to one another:

Esthonian and Finnish.

thonian, of which there are two principal dialects, the *Rewal* dialect spoken in Esthonia and the Island of Oesel or Samez, and the *Dorpatic* in Liefland, the language of the Lieffs or aboriginal inhabitants of Liefland; the Finnish proper, the dialects of which are classed into two divisions—the *West* and *East Finnish.* The language of the Laplanders, of which there are a great number of dialects.

2. *Languages of the Volga Finns.*—The Finnish nations who occupy the basin of the middle Volga in the governments of Kasan, Nishne-Novgorod, Simbirsk, and Pensa, comprise the Tchuvatch or Tchuvash, Tcheremiss and Morduins, each of whom speak a distinct language which has several dialects. The Tchuvatch or Sujasch, of which there are, at least, two dialects, is so beturked, that but few Finnish words remain. This is also the case with the Tcheremiss, but in a less degree In the neighbourhood of the Ural Mountains the fusion of Finnish and Turkish elements has produced a new language spoken by the Teptiars. There are two dialects of the Morduin separated by the Volga, and so different that the people of one side understand with difficulty those of the other.

Tcheremiss, etc.

3. *Languages of the Permian Finns.*—The Permian Finns occupy the country about the Lower Kama, the regions of the Lower Dwina, and the mouth of the Mosen. The eastern boundary of this branch was formerly the Ural chain, but has been pushed westward by the Voguls and Ugrians. This branch comprises the languages of the Votiæks (Voti or Voten), or as they call themselves *Uhd-Murd*,[49] the Syrjænians, and Permians proper. These nations speak languages which

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the most developed is that spoken in Finland, or Finnish proper. This must have been cultivated at an early period, because they have native words for writing (*kirjoittaa*) and for book (*kirja*). This writing was Runic, and has now been replaced by a Roman alphabet. The difference between the East and West Finnish may be shown by a few examples, thus, the personal pronouns, *myö*, *työ*, *hyö*, etc., in East Finnish, become *me*, *te*, *he*, in West Finnish. In the East Finnish dialects there is a great tendency for double consonants before diphthongs and long vowels; for example, the words *ìssäite*, *tullee*, *sannoo*, *lewwee*, in East Finnish dialects, correspond to *ìsäiti*, *tulee*, *sanoo*, *lewee*, in West Finnish. The influence of Swedish, among other causes, is quite sensible upon the West Finnish dialects. The whole subject of dialects, and the causes which have led to their development, has never yet been scientifically studied in any language, and yet it is the key of philology.

[49] Uhd=hospitable host, Murd=man; in Syrjænian mort=man, and also=homo Syrjænus.—*Castren, Elementa Grammatices Syrjænæ.*

Syrjænian, etc.

may be considered as dialects of a common language, which is called the Syrjænian, though it is rather the language of the Permians proper, to which the name applies, as the language of the Syrjænians may be considered a dialect of it. The Votiæks are of all the Finnic tribes the likest to the Finlanders. According to Russian authors,[50] they have a tradition among them that they emigrated from Finland. It is more probable that it was from the government of St. Petersburg, where Finnic tribes were displaced and partially absorbed by the Russians, at a comparatively recent period. There are still a few very small islands of a Finnic people in that government, called *Voti* or *Voten*, who are supposed by some to be the original people. The Permian Finns appear to have been once the most powerful and civilized of the Finnic nations, and to have carried on an extensive commerce and amassed great wealth. It was proprobably the *Bjarma land* of the Scandinavians, and hence probably the Russian name, Perm.

Vogul.

Ostjak.

4. *Languages of the Ugrian Finns.*—The nations grouped together as Ugrian Finns are the Voguls, the Obi Ostjaks, and the Magyars of Hungary. The two former occupy both sides of the Ural and the district of the Lower Obi, the country of the Ostjaks being the more northern of the two. The Voguls call themselves and the Ostjaks *Mansi Kum*, and in the south, where they are in contact with the Bashkirs, they have lost their nationality very much, while higher towards the north they appear to be new comers. The Ostjaks also call themselves *Mansi*, but sometimes also *Tju Kum*, *i. e.*, Swamp People, corresponding to the *Suomalaisets* of the Baltic Finns. They consider themselves as a branch of the Permian Finns; but the numerous dialects which they speak, and which in the north are mixed with Samojede elements and in the south with Vogul, are much more analogous to the latter. The Vogul has three principal dialects: one on the Irtysh or Irtish, the second on the Upper, and the third on the Lower Obi. The Vogulish has so much that is peculiar, notwithstanding its decided Finnic character, that it may be considered as an independent language.[51]

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[50] Rytschkow, Orenburg. Topographie, quoted by Müller—Stromsystems der Wolga, S. 389.

[51] Georgi, Beschreibung Aller Nationen, i. s. 65.

Magyar.

The Magyars of Hungary, the *impia gens Hungarorum* of the historians of the middle ages, appear to have come from some part of Asia into the districts between the Dnieper and the Don, towards the end of the seventh century; nearly two centuries later, having been dispossessed by the bastard Finnic-Turkish race, the Petchinakhi, they moved south-westward under Arpad, and passing by Kieff about the year 885, they poured into Hungary, Transylvania, Moldavia, and Wallachia, and subdued the Sclavonic and Daco-Roman population then occupying Pannonia. The language of the present Magyars is mixed with a very large number of words borrowed from the languages of the surrounding nations, but nevertheless a considerable number of the original roots remain.[52]

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[52] One of the most vexed questions in philology is the classification of this language. Some of the early Danish philologists, Rudbeck and Sajnovits (*Demonstratio Idioma Hung. et Lappon. idem esse. Havoniæ*, 1770) attempted to show its alliance with the Lapp, a doctrine which was supported by Hager (*neue Beweise der Verwandschaft der Hungarn mit den Laplandern. Wien*, 1793). Such an alliance was not pleasing to the national vanity of the Hungarians, and a different source was sought. Several writers, such as the learned P. Beregssässi, attempted to derive it from some of the eastern languages; others even fixed upon the Parthians as their forefathers. The remarkable work of the Transylvanian Gyarmath *(Affinitas Linguæ Hnngaricæ cum Linguis Fennicæ originis grammaticè demonstrata. Gottingæ*, 1799), in which he compared the Hungarian not only with the Lapp, but also and chiefly with the Finnic, and with the Esthonian, Votjak, Tcheremiss, Voguls, etc., so far settled the question that most philologists have since assumed the Magyars to be an Ugrian race. The Magyars themselves preferred being considered the descendents of the Huns, who entered Pannonia many times before. This desire to escape a Finnic origin, and learn who his ancestors were, once led an enthusiastic Magyar, Csoma de Körös, to seek among the far eastern Turkish race of the Uighur for the origin of his race. Later still (a few years since) another enthusiastic Hungarian, and one also like the other, a lover of science, Antal Reguly, has devoted himself, under the most depressing difficulties, to the study of the whole of the Ugrian dialects. From his correspondence, published by K. von Baer (*Beiträge zur Kenntniss des Russischen Reichs*, 9*th Bd.* 1*st Abth.*), he appears to think that the affinity between the Magyars and Voguls is very great, thus bearing out a remark of Schlözer's, that "the Voguls and the present Hungarians are the same people". We are not aware whether his results have been yet published, but perhaps it is upon his labours that the conclusion of Ladislaus Szalay (quoted in *Heyse*'s *System der Sprachwissenschaft*, 1856) is founded, namely, that the Magyars really belong to a Finnic race, and probably to the Chazar branch. The Chazars or Kosars were an Uralian Finnic race who occupied the delta of the Volga, and founded a flourishing city called Atel or Itil (this was also the name by which the Volga was known to the Byzantines), which was the emporium of the Indian and Asiatic trade, as we learn from oriental authors, already in the sixth century. In the

Uighur.

II. *The Jakutish-Turkish Group.*[53]—This group may be conveniently divided into four branches, as follow: 1. The Eastern, including the *Uighur*, *Tchagatai*, *or Old Turkish*, on the Mongol frontier about Lake Lob; it is the first Turkish language which has had an alphabet. The Uighur race is under the Chinese dominion; dialects of

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last quarter of the eighth century their empire extended to the Dnieper and the Oka, as is proved by their fortifying the line of the Don against the Petchinakhi (*πατζιναχιταί*). In the beginning of the eleventh century the empire of the Chasars fell, and the race itself was more or less beturked by the stream of Turkish hordes already pouring in by this the immigration gate of Europe. It is right to state that Dr. Latham *(The Natural History of the Varieties of Man, p.* 87), appears to assume that the Chazars or Khazars were Turks. His chief authority is the passage of Theophanes—*Τουρχοί ἀπὸ τῆς ἑώας, οὓς χαζάρας ὀνομάζουσι.* He also endeavours to prove that the Khazars and the Akatirs, the latter being undoubtedly the Huns of Priscus, were the same people. The weight of evidence appears to us to be against Dr. Latham's opinion as to the Turkish origin of the Khazars; and, on the contrary, his supposition that the latter and the Akatirs were identical, appears to be almost certain. In this case the Huns were Finnic if we make the Chazars so. Now this is exactly the conclusion to which one is forced by an examination of all the facts of the case. The Bashkirs, and especially the Meshtsheræks, a name which reminds one of Magyar, are probably the remnant of the Chazars, and are, no doubt, closely related with the Voguls, who have evidently, in common with the races just mentioned, been driven northwards by the Tatar invasion. It is certain that the travellers, Plano Carpini and Rubruquis, who visited the Great Khan of Mongolia (the former as Envoy of Pope Innocent IV.) in the years 1247 and 1253, call the land of the Bashkirs (Baschart, Pascatir), Great Hungary. Rubruquis also expressly says that the language of that country was the same as that of the Hungarians—See Bergeron—*Voyages faits principalement en Asia —La Haye*, 1735; and also *Recueil de Divers Voyages*, *Leide.—van der Aa*, 1729; and also in the former work the account of the Minorite Ruysbœck, who visited the Volga countries in 1253, in which he states that the language of the Hungarians and Bashkirs is the same; a statement in harmony with that of Rubruquis just given.

Connected with the origin of the Magyars and the empire of the Chazars, we may mention the city of Madshar or Madshary, noticed, according to Karamsin, in the Russian chronicles, in the year 1318, and the very curious and remarkable ruins of which Gärber, an artillery officer of Peter the Great, discovered about the year 1726-1727 upon the Kuma, a river which falls into the Caspian near the Caucasus, and directly south of Astrachan. As our space does not permit us to describe those ruins, we must refer the reader who is interested further in the subject, to the account of them given by K. E. von Baer, in the fourth vol. of "*Beiträge zur Kenntniss des Russischen Reiches.* Petersburg, 1841". As a singular circumstance to which we may hereafter have occasion to refer, we may state that Castrén discovered that there was a river called the *Madjar* in the Sajan mountains, a part of the little Altai chain, a region which, upon many grounds, has been assumed to be the original seat of the whole Finnic, and perhaps of the whole northern, family of nations.

[53] This name has been proposed by Otto Böhtlingk. Ueber die Sprache der Jakuten Einleitung S. XXIX.

the tribes of Uzbek Turks who are found at Khasgar, Kokan, Kodjend, Samarkand, Buchara, and a few as far west as Chiva; that of the Karakalpaks, south-west of the Aral Sea, between the Amu and Syr. 2. The *Western Turkish dialects* include those of the Tarekameh, Quisylbashi or Turkomans, from Balk to the Caspian, along the Persian frontiers (another portion of this race occupy the western side of the Caspian, along the Kur, almost to Tiflis). The Karatshai, Nogai, or Mankat, and Kumuk of the Caucasus, the Turks, erroneously called Tatars, of the west coast of the Sea of Azof and the Crimea, also belong to the Nogai. The language of the Osmanli or Ottoman Turks of Constantinople, the most polished and richest of the Turkish dialects, but now largely mixed with Arabic and Persian. 3. *Northern and North-western Languages.* This group includes Quirkis or Kirgis of Independent Tartary, who are divided into three hordes: 1. The great horde or Burut, from beyond the river Sara, Su, or Sari, to Lake Balkash, and south to Khasgar; 2. The middle horde occupies the region of the high table land north-east of the Aral Sea, between the Sari on the east, the sources of the Ishim on the north, and westward to Lake Ak-Sagul and the sources of the Tobol; 3. The little horde, who occupy the region about the Berdianka, the Ileck, and other tributaries which fall into the left side of the Jaik or Ural; the Jemba, which falls into the Caspian, and eastward to the Ulu-Irgis, which falls into the sea, or rather collection of shallow seas, the Ak-Sagul; the dialects spoken by the pure Turkish or bastard Turkish races belonging to Russia, and generally, but erroneously, termed Tatars, including the Baraba of the Barabinz Steppes, between the Obi and the Irtish; the allied dialects spoken by races formed of pure Turks, beturked Samojedes and Yenissei Ostjaks in South Siberia—the Tomsk Turks; the Kusmezk on the Upper Tom, Jarinar, Tubalar, Birgus, Teleuts, Karagass, Katschinsk, Koibals,[54] Sojots, and the Tobolsk Turks; Bashkirs, Meshtsheræks, and Teptiærs, between the Ural and the Jaik, in the government of Orenburg;—these three tribes are believed to be beturked Finns, and their languages to have a large Finnic

Uzbek.

Turkoman.

Osmanli.

Kirgis.

Siberian Turkish dialects.

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[54] The Koibals, according to Castrén (Reiseberichte und Briefe aus den Jahren, 1845–1849), belong to the unclassed race of the Yenissei Ostjaks.

Jakuts.

element in them; Tatars of Kasan. 4. Jakuts or Turks of the Lower Lena, or as they call themselves, Sacha; isolated tribes of the Jakuts are also to be found in the midst of the Jukagirs, one on the middle course of the Indagurka, from lat. 65° N. to 68°, and another about the mouth of that river, in the region of the *Tundra*, and beyond lat. 70° N.

Turkish dialects not well known.

The study of Turkish dialects has made but little progress; until very lately only two dialects, the Osmanli and, to some extent, the Uighur, were generally known. In consequence of this, it has frequently been affirmed that so little difference existed between them, that the language of Constantinople could be understood at Jakuzk in Siberia;[55] but we now know, thanks to the travels of von Middendorff and the grammatical labours of Böhtlingk, that the Osmanli and Jakutish are not so very similar; we believe considerable differences, grammatical and verbal, will be found between the multitude of Turkish dialects whose existence has been ascertained, when we shall know more about them than we can learn from the imperfect and generally incorrect vocabularies which we possess at present.

Berizine's classification.

Raschid-ud-din's.

Berizine[56] divides the Turkish dialects into three great groups corresponding to those above indicated (he leaves the Jakutish out of consideration); these three groups include nineteen dialects, which are distributed thus: to the eastern, he refers six; the western, five; and the northern, eight. Von Hammer[57] divides the Turks into twenty-four races—a classification founded upon that of the Persian writer, Raschid-ud-din, who manifestly confounds Mongolians and Turks in a great many instances.[58] Both classifications, and indeed all that we have seen, are manifestly based upon the most arbitrary considerations, and consequently we have adopted a purely geographical one, which, although not indicating the relationship of the different dialects, is at least convenient.

III. *The Samojede Group.*—The Samojede races con-

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[55] Klaproth.—Asia Polyglotta—S. 216.

[56] Recherches sur les dialectes Musulmans par E. Berezine—Première Partie—Système des dialectes Turks. Casan, 1848.

[57] Geschichte d. Osman. Reiches, Bd. x., s. 681–688.

[58] This conclusion has been arrived at from reading F. v. Erdmann's "Vollständige Uebersicht der Aeltesten Tuerkischen, Tatarischen, und Mogholischen Vœlkerstæmme nach Raschid-ud-din's Vorgange". Kasan, 1841.

Castrén's classification of Samojede larguages.

sist of three principal branches, each of which speaks a different branch language divided into a number of dialects:—1. the western or Jurak Samojede, which comprises five dialects; 2. the east or Tavgy Samojede (also called the Avam Samojede, from the name of one of the dialects), also comprising five dialects; 3. the south or Ostjak Samojede, with three dialects. Besides these three principal branches, there are two smaller ones, the Yennissei branch, spoken by a race who occupy the lower course of the Yennissei between the Jurak and Tavgy branches; and the Kammasinz, in the middle of Asia.[59]

Mongolian.

IV. *Tatarian or Mongolian Group* consists of three great branches, a division which also appears applicable to the languages. They are—1. the Mongolians, properly so called, who inhabit the inner table of Asia, called Mongolia, at both sides of the immense desert of Gobi. The Northern Mongolians constitute a more or less homogeneous people, the Kalkas, but the Southern Mongolians are split into a multitude of tribes.

Burjætish.

2. Burjæts, who inhabit the region about Lake Baikal, and belong mostly

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[59] Formerly the Samojede race was divided geographically and linguistically into two divisions—1. The Northern Samojedes, on the Lower Yenissei and along the Arctic Ocean into north-east Europe; and 2. the Southern Samojedes, in the highlands within which the Yenissei rises. The latter consisted of part, at least, of the *Sojots* or *Uliang hai* of the Chinese and the *Uriang chai* of the Mongols. This is a collective name employed to denote all tribes living in the Sajan Mountains. Among the Samojede tribes of this region, whether properly included among the Sojots or not, may be mentioned the Mators, the Arins, the Assans, the Karagass, etc., who roved as nomades partly within the territory of China and partly within that of Russia. They now speak Turkish dialects, but with certain idioms and peculiarities of dialects of a Samojede character. In religion they are Russians; in customs, habits, and dress, Turks. The single exception is the small horde or Uluss (the Abálakow), of the Kammasinz, who live within the region of the steppes, about the two small tributaries of the Yenissei, the Kana, and Mana. This horde comprises the so-called "Forest Kammasinz" of the Russians, the remaining two hordes being, one of Turkish, and the other of Yennissei Ostjak origin. They call themselves Kagmáshe, or in the plural Kagmashesang, and still retain a remnant of the Samojede mother tongue, which is rapidly becoming extinct. The vocal harmony, so characteristic of the entire family, existed in a much more perfect form in this dialect than in the more northern ones, in which it has become more or less obscured. We owe to the excellent and indefatigable Castrén, who visited the locality, a vocabulary of this dialect. It is also to him we owe the classification of the races given in the text, and the discovery of the true affinities of the Samojede group with the Finns. See his "*Reiseberichte und Briefe aus den Jahren*, 1845-1849. St. Petersburg, 1856", and "*Grammatik der Samojedischen Sprachen.* St. Petersburg, 1854".

Kalmuk. to Russia; 3. Oelœts or Kalmuks, composed of four chief tribes: Dsungar, Choshot, Torgod, or Turgut, and Durbet, who occupy the great steppes of the western tablelands between the Kuen-lun and the Altai, the Chuchu Noor and Lake Dzaisang. The Russian Kalmuks, who crossed the river Ural or Jaik in 1630, 1636, and 1703, and settled in the region at both sides of the lower Volga, but chiefly between that river and the Don, southward of Astrakan, were principally Torgod Oelœts. The greater part of them returned to Mongolia in 1771, on the invitation of the Emperor of China. A few isolated tribes of Mongols, known as Eimaks, are found in Northern Persia.

Mandchu. V. *Tungus Group*, comprising chiefly the *Western*, under which we may include the dialect spoken in the neighbourhood of Turachansk, on the Yennissei; the Tchapojir, about the Middle Tunguska; the Orotong about the lower Tunguska; and the Mangaseisk. *The Southern*, to which the following belong: the dialect about Kirensk on the Lena; that about Bargusin on the shores of Lake Baikal; that of the horse Tungus of Nertchinsk; the dialect of the Tungus on the Angara, near Irkutsk. *The Eastern*, including the dialects of the Lamut and Ochotzk, east of the Aldan Mountains on the shores of the Sea of Ochozk. All the dialects mentioned are spoken by tribes under the dominion of Russia, who, according to Hagemeister, do not in the aggregate exceed 35,000 to 40,000 souls.[60]

The languages spoken by Tungus nations under the dominion of China, are, with one exception, scarcely known. That one is the Mandchu, the only Tungus tongue which has an alphabet, which it has borrowed from the Mongolian. The Mandchu race which, since 1644, rules China, does not extend further north than lat. 46° N., according to Kimai Kim, a native Corean Catholic missionary.[61] North of the Sunggari, and between it and the Amur, which join one another, is found the nation of the *Ukin*, and further to the north-east, at both sides of the Suchalian, which is formed by the junction of the Amur and Sunggari, exists another nation known by the Chinese name of *Tu-pi-laze*, or Fish-skin Tatars. Both these people are believed to speak Tungus languages, but they are not known, nor are the dialects to the north-west along the Amur to the Russian frontiers near Nertchinsk.

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[60] Statistische Uebersicht Siberiens,—quoted in Castrén's "Grundzüge einer Tungusischen Sprachlehre, St Petersb., 1856".

[61] Revue de l'Orient, Mai, 1846, quoted in Berghaus's Physikalischer Hand—Atlas vii. Abth. S. 5.

SPORADIC LANGUAGES CONSIDERED TO BELONG TO THE NORTHERN FAMILY.—Philologists, under the influence of the Finn hypothesis, have successively added to the northern family a number of isolated languages, or groups of languages, which we shall enumerate in their order, proceeding from west to east. The affinities by which these languages are connected with those above enumerated are often very slight and unsatisfactory, and accordingly it is here that we become sensible of the confusion which prevails in the classification of languages, and of the very defective principles upon which the relative values of affinities are estimated.

Basque.

Euskaric.—This language, which is considered to be the remnant of the old Iberian, is spoken by the Basque or Escaldunac people in the Pyrenees, and is a kind of language island, left as a philological monument, showing the extent of denudation of the ancient races produced by the Indo-European floods.

Caucasian languages.

The Caucasian Languages.—This group includes all the languages spoken in the Caucasus, which have not been already classed under the Indo-European family or as Turkish, and may be subdivided into four branches: 1. Iberian branch (Georgian, Colchian, Suanic); 2. Abshas and Tcherkes; 3. Lesgian; 4. Mizshegian. There is so much affinity between the Georgian and the Ossetic, that, if the latter be made Indo-European, so must the former; a conclusion to which, indeed, Bopp appears to have come, inasmuch as he is inclined to consider the whole Iberian branch as Indo-European. Opinion varies very much upon this point, some philologists adopting Bopp's view, while many make the branch just named northern. But if this be added to the northern, so should, in strict logic, the Ossetic or Irôn and several others, perhaps also the Armenian; an alternative which Dr. Latham, indeed, accepts.

Tibetian.

The Tibetian. This language, although it is radically related to the Chinese, is not altogether monosyllabic, and consequently is intermediate between the Chinese and Northern families, to the latter of whom Schott refers it.

Indian.

The Drawida Languages of the southern part of the Peninsula of India and the various Hill Tribes.

Jenissei-Ostjak.

The *Jenissei Ostjak* along the Yenissei, and the various colonies of this branch in Central Asia within the

Chinese frontiers, most if not all of whom have now probably lost their mother tongue. The *Jukagir*, *Tchuvanz*, *Korjak Tshuktshen*, *Kamtshadale*, or languages of the races who occupy the north-east of Asia, eastward of the Lena. To these may also be added the languages of the *Aïnos or Kurile* chain of Islands, in which it has been found that the peculiar laws of construction of the northern family are observed.[62] The language of the Greenlanders was added by Rask himself, as we have already seen. Recent researches of Mr. E. Norriss have shown that the fundamental vocal harmony and other peculiarities of the languages of the Northern family also exist in the Japanese and in the languages of the Lieu Khieu Islands. It is probable that the languages of Corea partake of the same peculiarities, because it is a historical fact that the Coreans are the descendents of the Siän-pi, the Tungus nation which occupied the land of the Northern Hiong-nu or Chiungnu (Turks), and amalgamated with them when the Chinese Emperor of the Han dynasty defeated that people at the mountain Kinwei in the neighbourhood of the Upper Irtish.[63]

Languages of North-Eastern Asia.

Japanese.

We have now, as we hope, shown how the two hypotheses, which we have selected as examples, have been built upon the results of investigations conducted in accordance with the abstract principles of comparative grammar. Our next step is their verification, or, to speak more correctly, to show how this has been attempted to be done. In the sense in which that term would be used in astronomy or any of the exact sciences, there cannot be, if indeed there ever can be, an absolute verification of ethnological hypotheses. We should not, however, on this account, neglect to avail ourselves of such imperfect substitutes as are offered to us. A science may afford several methods of verification: the more complex the subject, the more numerous they are likely to be. Although philological ethnology is an eminently complex subject, yet, strictly speaking, historical evidence is the only means hitherto available for the purposes of verification. But does history tell us of an Indo-European migration? Some writers answer in the affirmative; and accordingly we propose to state in what way

Verification of hypotheses.

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[62] Berghaus. Physikalischer Hand-Atlas, vii. abth., S. 6.

[63] Klaproth—Asia Polyglotta. Paris, 1823. S. 238, also 211.

and how far it does so. At this stage we do not propose to venture to put forward any opinions of our own, and what we shall say, as well as what we have already said, must therefore be looked upon merely as a summary of the most advanced views of recent writers.

Condition of parent Indo-European race.

History does not inform us of the condition of the parent people from which it is assumed the Indo-European nations have sprung. But knowledge of this kind would be very useful, indeed is indispensable, to enable us to exercise a critical judgment upon the obscure events which constitute the only historical evidence which can be brought forward to support the presumed migrations of races. We must accordingly seek for this information in some other quarter, or rather in the only one to which we could look—an examination and comparison of all the words expressing family relations, government, cultivation, etc., now existing in the Indo-European languages.

Was there but one, or were there several Indo-European migrations?

We have seen that, independent of the doubtful members, there are six great groups of languages of the Indo-European family: the western division, comprising the Keltic, Pelasgic, German, Sclavonian; 2. the eastern, comprising the Persian and Sanscrit languages. Now, the question naturally suggests itself, did these nations migrate from the common country at one and the same period, or were there separate successive emigrations at distant intervals of time? Some adopt the opinion, that there were several distinct emigrations, that of the Keltic family being the most ancient, and of the Indian the most recent. The unequal development of grammatical organization which the different members of the family exhibit, and other peculiarities, are considered by many to favour the latter view. The other opinion is, that the emigration was simultaneous, or that at least the European portion was part of the same great wave; the grammatical differences being accounted for by contact with, and incorporation of, foreign elements, as the wave of population progressed westward, the Keltic being assumed to have been modified by members of the northern family, and the Sclavonic by the Semitic, as we shall see by-and-by.

Ideas of family among the parent race.

The comparison of the different categories of words alluded to above, in all the Indo-European languages, has led to some extremely interesting conclusions. There is an almost complete agreement between them in the words expressive of the relationship of members of the same family. In most cases, too, their original meanings are discoverable, and these give us glimpses of the character of the family idea in the oldest time. Thus for example: brother was considered as the protector as well as the father, sister as the foundress of a new family, daughter as the milker.[64] The form of government must have also advanced beyond the condition of the patriarchal family, because we find a Sanscrit word *viç pati*—Zend, *vîç paites* the master or lord of a place (*viç* being intermediate between a house and a city), exists in Litthuanian in the form *wiesspati*, a man of rank, a lord, and *wiesspatĕnĕ*, a woman of rank. *Patnĭ* signifies in Sanscrit a woman, and in Greek the second part of the word is **πόσις** instead of **πότις**, Latin *potis*, feminine **ποτνία**, mistress, and forms the second part of the word **δεσπότης**, a despot, feminine **δέσποινα**, which is a retrenched form of **δεσποτνία**, the original meaning of which was protector, as it comes from *pâ*. *Pâla* in Sanscrit has the same meaning; and the words for father in the European languages come from the same root. Thus from the same root two derivatives have been made, one of which expresses protector of the family, and the other protector of a number of families. The same root *pâ* is also found in the Sanscrit word *gôpâ* or *gôpa*, which originally and still means shepherd (cowherd), but at the same time also protector and defender in general, and in this sense was applied to the gods. It also signifies king, as *gôpalâ* and *gôsvâmin*—originally a possessor of cows. These words prove that the Arians were originally ruled by shepherd kings.

Form of government.

The most usual words for *king* in Sanscrit are *Ràg'* and *Ràg'an*;[65] they correspond to Latin *Rex;* Gothic, *Reiks;* Irish, Rıġ. The root of these two words is dittologous: in the first word it appears to have the force of *regere*, to judge; in the second it must mean to shine, but, at the same time, to rule; for the Sanscrit word for silver, *rag'ata*,—Gr., ἄργυρος; Lt., argentum; Irish, aıꞃġeaꝺ, is derived from it. The king, therefore, appears in the high position of judge.

Mode of warfare.

The commonest mode of warfare of the parent Indo-Europeans appears to have been in chariots. *Ratha* is the Sanscrit for chariot, and in the Zendavesta the warriors are called *rathaêstâo*, that is, standers upon chariots. Their chief occupation was the herding of cattle, as is proved by the great number of words, especially in Sanscrit, which appear to have originated in pastoral habits. Great wealth was connected with the possession of cows; and the vedas are full of allusions to the ancient pastoral life. The words for cattle, and several of the domestic animals, such as goose, swine, boar, etc., are common to several members of the family. This pastoral life was not apparently the nomadic life of the Mongolians or Turks, but a fixed one, the land being cultivated to some slight extent. Agriculture could not, however, have been much practised. While the East Arians (Indians and Persians) have the same word for plough, the European members of the family have different. And J. Grimm[66] has shown that there is much more frequent identity between words connected with pastoral life, than between those relating to tillage. That they were acquainted with corn to some extent at least, is proved by the word *java*, Sanscrit for barley, existing in one at least of the European languages, though applied in a generic instead of a special sense—namely, the word *jawai* (plur.), which in Litthuanian signifies corn or grain generally. Perhaps part of the original race, who owned the rich valleys, tilled the lands, while those who occupied the plains were only shepherds. We have many examples of this kind in the present chanates of Chiva and Buchara, forming part of the supposed original home of the race. Connected with the question of a single or several successive emigrations, we may mention a circumstance which speaks in favour of the former view, or rather in that of the simultaneous wandering from the original seat of the race, and the subsequent splitting up of the migrating horde after it had come in contact with civilized Semitic people; namely, that many of the words connected with tillage are common to Greek, Latin, German, and Sclavonian. Agriculture must also have been early practised among the Indian Arians; for the word *Krisht'i*, which is derived from the verb *Krish*, to plough, was a common expression for men at an early period.[67]

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[64] S. A. Kuhn—Zur Aeltesten Geschichte der Indo-Germanischen Völker. Osterprogramme des Real-Gymnasium zu Berlin aus dem Yahre, 1845, p. 3. Also, Lassen-Indische Alterthumskunde, Bonn, 1847, 1str Bd., S. 813.

[65] *Rig'u*, superlative *rag'isht'ha*, means direct, therefore, the straightest way; *rig'ûju*, loving the right. *Ante* note 64.

Occupations.

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[66] Geschichte d. Deutsch. Sprache. S. 69.

[67] The following observations of Professor Wilson, on this subject are interesting:—

Weaving appears also to have been known to the parent race, as the word for it is common to several languages. They also had regular houses.[68] At an early period too there must have been considerable associations of people among the parent race, because in addition to the word *viç*, already mentioned, denoting a place, we find already in the vedas the word *grâma* for village, and the word *pur*, or in the later form, *purî*, for city. Now the word *viç* is probably the root of the Latin *vīcus*, village, and of the great number of derivatives which have been formed from it; while the Greek πόλις = city, corresponds exactly with *purî*.

Associations of people.

Curious glimpses of the state of intellectual development among the people of the parent stock may also be obtained from a study of the words expressive of abstract ideas, religious or otherwise; but this is not the place to dwell further on the subject. Those who are interested in it will find a good deal of matter in Grimm's work above quoted. In the second part of this paper we hope to employ this kind of investigation in a new point of view.

Intellectual development.

The preceding observations upon the parent race will prepare us for discussing with more advantage its subsequent migrations. Of the emigration eastwards and southwards to Persia and India, we purpose to say nothing, referring those who wish to study that part of the subject to Lassen's great work on Indian Antiquities. The subject consequently narrows itself into the migrations of the Pelasgic, Sclavonian, Keltic, and German branches, which we shall treat of in the order named.

Migrations of parent race.

"At this period (epoch of the earliest of the Vedas) a pastoral people they might have been to some extent; but they were always, and perhaps in a still greater degree, an agricultural people, as is evidenced by their supplications for abundant rain, and for the fertility of the earth, and by the mention of agricultural products, particularly barley". . . . "They were a manufacturing people; for the art of weaving, the labours of the carpenter, and the fabrication of golden and of iron mail, are alluded to; and, what is more remarkable, they were a maritime and mercantile people". *Rig Veda Sanhita. Translated by H. H. Wilson, p. 57.*

[68] In Sanscrit *dama;* Gr., *δῶμα* Lat., *domus;* Rus. *domi.* According to Grimm, the Gothic word *timrjan*, to build, contains it, being related to Δέμειν (Ion. pro. *οἰκοδομέιν*) to build a house. A similar correspondence may be observed between the parts of a house; thus, for example, *door*—Sanscrit, *dvâr;* fem., *dvâra;* Old Persian, *dhuwara;* Kurd, *deri;* Armenian, *durhn;* Gothic, *daur;* Gothic of the Crimea, *thurn;* old high German and old Saxon, *dor;* Lett. *durwis* (*durris*); Litthuanian, *durrys;* Rus., *dver;* plural, *dveri;* Greek (plural), ϑύρα; Aeol., ϑȣρα; Irish, ꝺoꞃaꞅ perhaps the Irish ꞇıᵹ̇, a house, is similarly related with the Gothic *timrjan.*

If we accept the Fin hypothesis, the countries into which the Indo-European immigrations took place must have been fully inhabited. In their route westward lay the fertile regions watered by the Tigris and Euphrates, and the rich Asiatic countries bordering the Mediterranean, and we may also add Egypt. Those beautiful regions, once teeming with abundance, now partially converted into deserts, or withering under Turkish rule, were the seats of great empires, of a high civilization, of rich and flourishing cities filled with magnificent palaces, even during the mythological period of Grecian history, and long before the dawn of its chronology. If such a movement of races took place, it must have been excited by the same causes, especially the love of plunder, which in historic times, between the fourth and seventh centuries of our era, brought those hordes of barbaric people into Europe who destroyed the ancient civilization of Greece and Rome. No doubt the conquests of the Babylonian and Egyptian princes carried the fame of their power, magnificence, and wealth, as did those of Rome at a later period, far into the heart of Asia.

The countries traversed were already peopled.

Plunder the inducing cause.

Although we have no accurate chronological histories of Babylon or Egypt in which we might hope to find a record of such a migration, yet so mighty an event could not have occurred without leaving traces of it in the monuments of those peoples, and especially in their monumental inscriptions. The supporters of the Indo-European hypothesis have accordingly sought for such traces in Nineveh and Egypt, and have ransacked every legend and myth of Greece, and have done much good service by their labours in the field of ancient history, if they have not gathered much fruit of the kind they sought. The more sanguine theorists have found abundant facts in favour of their hypothesis. Whether the proofs thus supposed to be obtained are such as would satisfy the requirements of strict logical inductions, we will not now attempt to determine. The illustrations which we propose to give of those speculations will, we hope, enable our readers to estimate their general character, and their value as historical evidence.

No accurate chronological history of such migrations.

Some writers think they can discover traces.

Perhaps the most positive speculations are those of Kruger,[69] because he is not satisfied with connecting

Kruger's speculation.

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[69] Die Eroberung von Vorderasien, Egypten und Griechenland durch die Indo-Germanen. Von J. Kruger, Bonn 1855, as the first part of his "Urgeschichte des Indogermanischen Völkerstammes".

events, which stand, as it were, between the mythological and historical periods of ancient history, with the migration of the Indo-Europeans, but he even attempts to make a chronology.

Röth's opinion that the Pelasgi were the Hyksos.

One of the most remarkable speculations in ancient history is that of Röth,[70] about the Hyksos, an Asiatic shepherd people, who suddenly burst upon Egypt, then at the height of its glory under the twelfth dynasty of the ancient empire, devastated it, erected a new empire, and fixed its seat at Memphis. The new dynasty, which is known as that of the "Shepherd Kings", founded a great fortress in the Delta against the Assyrians, a kind of military camp, said to contain 240,000 soldiers, and is said to have ruled 511 years, when it was overthrown. According to Röth, the Hyksos, on the fall of their dynasty, appear as the Pelasgi, about whose origin so many hypotheses have been broached. This opinion of Röth's appears to receive corroboration from the discovery which has been made of Doric columns among the ruins of the temples of the ancient empire, while none could be found among those of the new empire which succeeded the Shepherd Kings.[71]

Lepsius thinks the Aamu were Hyksos.

Now Herodotus appears to consider the Ionians as Pelasgi, and Böckh's researches lead him to the conclusion that the latter were not a foreign race, but an earlier phase of the Hellenic nationality. Rhode,[72] and perhaps others also, have pointed out an Arian or Indo-European element mixed with the Coptic. Röth has also given it as his opinion that the religion of the Hyksos was Arian or Indo-European, and Josephus states that the name of their fortress, Avaris, was derived from an old myth of the gods; but, according to Röth, the chief god which the Hyksos brought into Egypt was the Arian sun god *Hvare* (Horus). Lepsius, in his Egyptian travels,[73] speaks of the race of the Aamu, who wandered into Egypt under the twelfth dynasty, towards the end of the twenty-third century B.C., according to the chronology adopted by him, and whom he considers as the predecessors of the Hyksos and to have been of their race. They are represented upon the Egyptian monuments with fair hair and blue eyes, characteristic of the Indo-Europeans. Bunsen and Lepsius have both rendered it probable that the horse was introduced into Egypt by the Hyksos. That animal appears nowhere on the monuments of the ancient empire, while it formed the chief power of the Egyptian chariot-warriors under the new dynasty. It is also certain that the oldest Semitic races did not know the use of the horse to the same extent; and, according to Herodotus, the Arabians in the army of Xerxes rode camels. Layard alludes to the fact that the Arabian horse, which has since become so celebrated, is not alluded to in the Bible, while it is often mentioned by the Assyrians; he further states that the Hebrew words *Sûs* and *Parasch*=horse, are derived from Susa and Persis, a signal proof, therefore, that it was foreign to the Hebrew people. As specimens of the kind of etymological arguments used in support of the Hyksos hypothesis, we may mention the attempt to explain Palestine to be Baal's land (*stan*=land). Pelusium, the subsequent name of Avaris, Pelasgi, Pelistim, are also believed to contain the word Bel or Baal. As the journey of the Israelites into Egypt took place under the dynasty of the Hyksos, the word Goschen is connected with the Sanscrit word *Goshana*=shepherd land. Again, there is every reason to believe that the Philistines were not Semitic, and Hitzig,[74] has even attempted to prove that they were Indo-Europeans. The other name, Carian, by which they were known, Kruger endeavours to connect with the word *car*=master, in Sanscrit and Zend; *hâr*, in old Norse; modern German, *herr;* that is, that they were the noblemen or lords in the land. Finally, the words which Bohlen[75] has adduced, in order to show the relation of Egyptian names with Sanscrit, may be added to the list; among these we may mention Ægyptus=*Agupta*, the hidden; Isis=*îsî*, the mistress; Amenthes, the Egyptian underworld=*Amanthas* in Sanscrit.

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[70] "Geschichte unserer Abendländischen Philosophie" as first vol. of "Die Egyptische und die Zoroastrische Glaubenslehre als die ältesten Quellen unserer speculativen Ideen. Von Prof. Eduard Röth, Manheim, 1847.

[71] Studien und skizzen aus den Ländern der alten Kultur. Von. Dr. Jul. Braun Manheim, 1854.

[72] Die Heilige Sage und das gesammte Religionsystem der Alten Baktrer, Meder, und Perser, oder des Zendvolks. Von J. G. Rhode, Frankfort, a. M. 1820, S. 5.

[73] Briefe aus Egypten. Berlin, 1852. S. 97.

Horse introduced into Egypt by the Hyksos.

Specimens of etymological argument.

Upon these and similar data Kruger endeavours to prove that the East Arians or Indo-Europeans, under the name of Medes, advanced westward in the twenty-third century B.C., took Babylon, and established the empire of the

Indo-Europeans or Medes were the Aamu

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[74] Mythologie und Urgeschichte der Philistäer. Leipzig, 1845.
[75] Das Alte Indien, Bd. ii. S. 456.

and afterwards the Hyksos.

Medes; that about the same time their advanced posts penetrated into Egypt (2,200 B.C.), and were the fair-haired, blue-eyed people called *Aëmim* or *Aamu*, who appeared before the Pharao Sesurtesis II., and who must have been such an object of wonder to the black Egyptians, that they handed down to posterity the careful representations of them. Under the next king, Sesurtesis III., the first Sesostris of the Greeks, the glorious twelfth Egyptian dynasty reached the summit of its power. Obelisks, pyramids, noble palaces, tombs hewn in the solid rock, the world-famed labyrinth, the artificial lake Maeris, all attest the high cultivation, great wealth, and therefore extensive commerce and external-world relations of Egypt at this period. Sesostris appears to have fought successfully against the advancing Arians, for prisoners of this race appear often in the warlike scenes or tournaments represented upon the monuments, as the German prisoners of war were often the gladiators of the Romans. But to this splendour of Egypt followed suddenly a frightful downfall, at the same moment that an avenger of the oppressed Chaldean people arose in the north. In the year 2,100 B.C., Ninus, the Assyrian, destroyed the empire of the Medes, and scattered the Arian people; one portion went northward under the name of *Haik*,[76] another went south, destined to play a great part in the world's history. As Pelic Hyksos, they ruled the land and people of Egypt for centuries. But this conquest did not end their struggle with the Assyrians, for it lasted yet a long time. They sought to protect themselves against these world-conquerors by the great wall of Avaris; but the mighty Semiramis conquered them, and even, it is said, advanced as far as Ethiopia. Nevertheless, under her grandson, Arius, or Ariuch, a second campaign was necessary, which, however, only brought for some time the Palestine Hyksos under the Assyrian yoke.

For 260 years the dread of the Assyrians kept the race of the Hyksos together, but as that diminished, the bonds of harmony weakened. The Hyksos, occupying the interior of the country, adopted the customs and religion of their more civilized subjects, and thereby exasperated their northern fellow-countrymen. At length, under Apophis, the last king of the first Shepherd Dynasty, it came to open civil war. His own family joining with the Egyptian people, he was dethroned, B.C. 1840, and, with his adherents, driven to the sea and expelled from Egypt. His son, Danaos, or Ion, laid the foundation of a mighty state in Argos, which ennobled the primitive inhabitants of the country, the forefathers of the Illyrians and Albanians. Another part of the adherents of Apophis, the Agenorides, conquered Syria, where they remained as Cadmonites until the fall of the second Hyksos dynasty in Egypt, 1589 B.C. About that time the Egyptians rose against their rulers and besieged Avaris with 480,000 men, and compelled them to leave Egypt, but allowing them to depart with their goods and families. They went to the number of 240,000 men to Palestine, driving northwards a wave of Semitic populations; the latter, in turn, driving the Hyksos, and especially the Cadmonites, settled on the coast, on the sea. Mixed with Semitic elements, these followed their brothers of the same race, and peopled Crete, Cillicia, Lycia, Rhodes, Tharos, Thracia, and Hellas. Cadmos especially appears to have been for middle Greece what Danaos was for southern.

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[76] St. Martin, in his "Mémoires Historiques et Geographiques sur l'Arménie, Paris, 1841", tom. i., thus describes this advent of the supposed Arians into Armenia:—"The first general or prince who governed their land was a certain Haik. About 22 centuries before cur era he left his native country Babylon and settled down with his entire family among the Armenian mountains, in order to escape from the tyrany of the Assyrian king, Belus. This prince, enraged at his secession, collected a numerous army and attacked Haik in the midst of his new settlement, but the fortune of arms decided against the Assyrians, and defeated in a great battle he lost his life."

Downfall of first Hyksos dynasty.

Foundation of Argos by first Hyksos colony under Danaos.

Total overthrow of Egyptian Hyksos, and second migration to Greece under Cadmos.

The greater part of the heroes of Avaris remained in Palestine, and as the nations Emim (perhaps more correctly Aêmim, and then connected with the Aêmim or Aamu, a few of whom wandered into Egypt, as already mentioned, under the Pharao Sesostris II.), Chorim, and Ennakim, of the Bible, lived in bitter strife with the Semitic people until their destruction by the Israelites, B.C. 1,300, in entering Canaan from Egypt. This exodus of the Israelites has been identified by Lepsius with that of Osarsiph, and therefore totally unconnected with the previous Hyksos emigration. The children of Enack are mentioned in the Bible as giants; the Hyksos were also considered so in Egypt; and what is singular, St. Martin[77] has a remarkable passage in which St. Ephrem, who lived in the middle of the fourth century, mentions the Kurds, Armenians, and their neighbours, as the descendents of

Emim, Chorim, and Enakim of the Bible, assumed to be Hyksos.

Armenians descendents of the Medes.

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[77] Mémoires Historique et Géographique sur l'Arménie, tom. ii. p. 255.

the giants; and Kruger even endeavours to connect the Armenian word Hesgaï = giant, with Hyksos and Haik.[78]

Solution of Mythos of Epaphos.

Kruger hopes that the question of, who were the Pelasgi? is now solved for ever. He accordingly believes there was no Argos before Danaos, and no Pelasgi, for with him came both name and people. He would seem, therefore, to refer the mythological genealogy given by Apollodorus and others, in connection with the mythos of Epaphos and Danaos, commencing with Inachos and ending with Danaos, Europa, Cadmos, and their children, to two periods, the one antecedent to the arrival of Danaos in Greece, and the other to that of Cadmos. In corroboration of this view he states that the latter name is found among the Phrygians and Armenians, and even in India.

Kruger's promised future researches.

Kruger promises to continue his researches on the history of the Indo-European family, and states that he is in possession of a Persian chronology which goes back to 2308 B.C., but giving positive dates for certain events as far back at least as 1118 B.C., and whose correctness is corroborated by its remarkable harmony with the Chinese, Egyptian, and Grecian chronologies. By means of this he believes he will be able not only to determine, in a general way, the period at which Zoroaster flourished—a point about which writers have differed, even to the extent of thousands of years—but also to assign positive dates for some of the principal events of his life. This chronology is to form the second part of the work already quoted, but which we have not yet seen.[79]

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[78] If the Irôn or Ossetii be really Indo-European, and that their name (Irôn) be derived from Iran or Persia, they should, upon Kruger's hypothesis, be part of the scattered Medes. Some form of the word *Haik* ought, therefore, to occur in their language. We have, however, failed in finding such a word in the "*Ossetische Sprachlehre*" of Sjögren (St. Petersburgh, 1844). No word for *giant* is at all given in the dictionary attached to that work.

The circumstance that one of the six races with blue eyes and fair hair, mentioned in the Chinese annals, was called *Hakas* (Klaproth, "*Peuples de Raçe blonde*", in his "*Tableau Historiques de l'Asie*", *p.* 161–186), adds considerably to the interest which Kruger's speculation has attached to the word *Haik.* These Hakas subsequently became the Kirgis; but Ritter (*Die Erdkunde von Asien, Bd. I., S.* 434), who considers the whole of these fair races to be Indo-Europeans, looks upon the Kirgis as a mixed race, composed of the remnant of the Hakas and Turks, to which must probably be added part of another fair race, the U-Sun (the Hieou-Siun of older, and the Ou-Si-un of later Chinese annals—*Abel Remusat—Remarq. s. l'extens. de la Chine Occid.* p. 96, quoted in Ritter, as above). In opposition to this, it may be urged that the Kirgis language is one of the purest Turkish dialects. But then, on the other hand, the Kirgis have more or less of a Mongolian type; and yet, scarcely any Mongolian words are found in their language. It would be of the greatest interest to examine the Kirgis dialects thoroughly for an Indo-European element.

Dr. Donaldson's hypothesis of the Median origin of the Sclavonians.

The most recent hypothesis proposed respecting the line of migration of the Sclavonic members of the family, is that of Dr. Donaldson.[80] We shall merely state the hypothesis in general terms, and refer the reader for the arguments urged in its support, to the admirable memoir of the author. The basis of the hypothesis is the assumption that the Sarmatians (Σαυρομάται of Herodotus) and the Sclavonians were identical. Opinion is, however, divided upon this subject; Schafarik, perhaps the greatest authority upon Sclavonic philology, holding very strongly the view that they were distinct races.[81] Most scholars, on the other hand, agree in considering the Sarmatians as Medes. In a passage of Diodorus we are told that, during the Scythian possession of Asia Minor, Mesopotamia, etc., about the year 633–605 B.C., several of the conquered nations were transplanted to other regions, the most important of which were the Assyrians, who were located in the lands between Paphlagonia and Pontus, and the Medes to the region about the Tanais, and that these Medes were the subsequent Sarmatians. Pomponius Mela considers them to be nearly allied to the Parthians; Pliny and Ammianus Marcellinus also support the Median origin of the Sarmatians.

The chief tribes of the Sarmatians were the Jaxamatæ (Ιαξαμάται), the Roxalani (Ρωξολανοι), Iazyges ('Ιάζυγες), and the Alani. According to Gatterer's etymology, which is very generally received, the name Sauromatæ signifies the northern Mateni or Medes, while the name of the Jaxamatæ signifies Medes from the Jaxartes. If the original centre, from which the Indo-European parent race issued, be considered to be the Ak-tag and Mus-tag mountains, that is, that part of the western continuation of the Thian-Chan chain which crosses the Belur-tag chain almost at right angles, and the latter chain itself, corresponding in part to Kaffiristan, the country of the

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[79] It was to have been published under the title of "Wiederherstellung der Persischen Chronologie und Geschichte des Zweiten Assyrischen Weltreichs nach Persischen Quellen".

[80] On two unsolved problems in Indo-German Philology, by the Rev. J. W. Donaldson, D.D. Report of the British Association, vol. xx., p. 138 (Ipswich, 1851).

[81] Slawische Alterthümer, Bd. i., S. 333.

Siaposh, forming the watershed of the Oxus or Amou, and the Cabul, the race must have already extended itself westward, as far as the Tigris, at the period of the Median empire. Either then or later it is considered to have become subdivided into four branches: 1. the Arians, properly so called, who spread themselves over the Hindoo Koh, and thence over the mountains overlooking the Indus, whence they poured into Hindostan; 2. the Sacæ (Σάκαι), who occupied the Khorassan mountains and the country extending to Buchara and the valley of the Amou; 3. the Medes or Matians, who occupied the region about the South Caspian to the Assyrian frontier; and 4. the Persians, or as some call them, the Germanians. Now the question arises, were the Jaxamatæ or Medes of the Jaxartes the same as the Sacæ? The latter are evidently the Se, Sse, or Sai of the Chinese, and the Δάαι of Herodotus. They are usually classed among that undefined group of people, the Scythians, whom Schafarik concludes, though we think without reason, to be Tchudes or Ugrians. So that the Median origin of the Sclavonians has two difficulties standing in the way of its adoption; one, the identity of the Sarmatians and Sclavonians; and the other, the doubt as to who were the Sacæ of the Transoxiania or the region of Buchara and Khokand.

Assuming that these difficulties be removed, the Sclavonians are descendents of the Medes, and must have been in contact at a very early period with Semitic people; and, consequently, the Sclavonian dialects ought to exhibit traces of that contact. But the Semitic and Sclavonian languages stand in direct antithesis to one another, the distinctive characteristic of the Semitic languages being the general triliteral character of the uninflected words, to which we have already adverted, and the invariable syntactical contrivance by which the whole mechanism of speech is carried on. Dr. Donaldson attributes this result to the early adoption of alphabetic writing, the establishment of a literature, and the unusually frequent intermixture of cognate races. In the Sclavonic languages, on the other hand, the etymological forms are perfect, and there is a total absence of merely syntactical contrivances—circumstances that may be accounted for by the late period of the development of their literature, and that the Sclavonic people are the least mixed of any of the branches of the Indo-Europeans. If, then, Sclavonic languages exhibit any traces of the contact with the Semitic, the argument would be the stronger from the unfavourable character of the circumstances under which the evidence would be obtained. Dr. Donaldson thinks, however, that there are verbal and phonetic coincidences between the Sclavonic and Semitic languages which cannot be accidental, and which are not traceable to any subsequent intercourse between the two races, and which are not found in the other European languages. He also points to the circumstance, that the distinction into perfect and imperfect verbs, which is so characteristic of Sclavonian dialects, as we have already mentioned, is common to all Semitic languages. Putting these and other circumstances together, and to which our space forbids us to refer, he concludes that the Sclavonians were Medes, and were, consequently, in contact with Semitic populations on the Assyrian frontier. Again, remembering the name Jaxamatæ, or Medes of the Jaxartes, the route by which they entered Europe must have been from the borders of Assyria, through Media and Hyrcania, round the eastern shores of the Caspian and Aral Seas, across the Tanais into Russia.

Kurds and Irôn also descendents of Medes.

As corollaries to this Median origin of the Sclavonians, we have two other hypotheses: one, that the Chaldeans, Kasdim, or Kurds, were also Medo-Persians. They are generally admitted to be an Indo-European tribe, who descended from their mountains and conquered the plains of Mesopotamia about the time of the prophet Isaiah. Some writers have claimed for them an alliance with the Sclavonians; and even those who deny this, as Ewald, look upon them as Medo-Persians. The second is, that the Irôn or Osseti of the Caucasus are descendents of the Alani, one of the Sarmatian tribes; and, consequently, upon the assumption that the whole Sarmatian race was Mede, the former must also be so, and specially related to the Sclavonians.

Conclusion from Hyksos and Sclavonian hypotheses.

Connecting the Sclavonian and Hyksos speculations, and assuming them to be established, the conclusion to which they would lead would be, that the Pelasgi, Sclavonians, Armenians, Kurds, and Osseti, were all Medes, and the downfall of the great empire of the Medes, the date of their separation. There is one important difficulty which suggests itself when the hypotheses are thus placed in juxtaposition, and which we cannot help mentioning: it is this: if the Pelasgi be Medes, why should not the

Greek and Latin exhibit as characteristic traces of contact with Semitic peoples as Dr. Donaldson assumes the Sclavonic dialects do? May not traces of so important a distinction as that between incomplete and complete verbs be found in early Greek, or still more probably, in the more ancient Latin, before the kind of literary action which is even now obliterating them in certain dialects of the Sclavonian, began to operate? Such an investigation, if it has not been already made, would possess great ethnological interest.

No consistent hypothesis for Keltic migration.

No consistent hypothesis has ever been proposed respecting the immigration of the Keltic tribes, for the simple reason that, although there have been more books written, and more theories broached about them, ethnologists, whether philological or physiological, have, generally speaking, possessed pretty much the same kind of knowledge about the Kelts and their language, as they have about the tribes and languages of Central Africa. The only definite hypothesis respecting their route into Europe, in accordance with the Indo-European hypothesis, is that suggested by K. Meyer.[82] According to him, the Kelts came from Asiatic Scythia, which would seem to imply that they originated from the tribe of the Indo-Europeans which we have called Sacæ, who occupied the region about Buchara. The immigration was not single, but consisted of several successive ones, divided into two distinct periodic streams flowing in different directions. The first was supposed to flow through Syria, Egypt, thence along the northern coast of Africa, to the Straits of Gibraltar, through Spain and into Gaul, where it split into three streams, one flowing into Italy, a second along the northern declivities of the Swiss and Tyrol Alps and the valley of the Danube to the Black Sea, and the third into Great Britain and Ireland. The second route of immigration was more direct; it entered by the depression north of the Caspian, across the Jaik and Volga, through Russia, and thence partly through Scandinavia, and partly through Prussia, and along the shores of the Baltic and the North Sea into England. Intimately connected with this hypothesis of the Keltic migrations is the very curious speculation of Meyer about the Irish Fenian tribe of Usnach, or as Meyer terms it, *Uasin*, whose

K. Meyer's speculation.

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[82] On the importance of the study of the Celtic languages. Report of the British Association for 1847, p. 30.

destruction is described in the beautiful poem of oiḋe chloinne Uisneaċ (the death of the children of Usnach). This tribe he considers to be identical with the *U-sin*, one of the tribes of Central Asia, having fair hair and blue eyes, described, as already mentioned, in the Chinese Annals. We give this hypothesis without comment, but at a later period we propose to publish all that is known of this Oriental tribe, whenever the publication of a correct version of the Irish poem in the pages of this periodical may give us the opportunity.

The Germanic migration.

A recent writer affords us an opportunity of presenting, in its most matured form, the current opinions as to the line of immigration of the Germanic races.[83]

Ethnological survey of Europe before arrival of Germans.

After a few remarks in the usual spirit of the Neo-Germanic school, the principles of which have been so enthusiastically adopted in Scotland, about the Kelts, and also about their diffusion, he makes an ethnological survey of Europe at the commencement of European chronological history, which we shall endeavour to summarize in a few words. The extreme north-west of Europe, and the northern shores of the continental main land, were then occupied by the Gaelic Kelts in Ireland, North Britain, and Gaul; the Kymric and other Kelts, as the Welsh of England, and the Cimbri and Teutones (considering them as Kelts), lived on the shores of the North Sea, this being the position into which successive waves of people coming westward had driven them, as the first intruders into Europe. The Hellenic and Kelto-Italian successors of the Pelasgi occupied Greece and Italy, together with, in the latter, the intrusive Semitic Rasena or Etruscans. Spain and Portugal were peopled by the Iberi and Celtiberi, and some Phœnician or Punic colonies. Phœnician colonies also occupied the Mediterranean islands, and a small colony of Phocians had just founded Massalia in Southern Gaul. Inside this fringe of Mediterranean nations, the whole of Central Europe—from the Atlantic to the Adriatic, from the North Sea to the Alps—was occupied by Keltic races; the valley of the Danube, and thence eastward to the

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[83] Dr. Daniel Wilson, Professor of History and English Literature, University College, Toronto (Canada), and author of "Prehistoric Annals of Scotland", "On the Intrusion of the Germanic Races into Europe"—Edinburgh New Philosophical Journal, vol. i., new series (Jan., 1855), p. 33.

Euxine by the Scytho-Sarmatian stock.[84] These races being all assumed to be intrusive, must have previously displaced some other people, and either absorbed, extirpated, or drove them forwards, as in turn they, pressed upon by fresh swarms from Asia, moved westwards, till at length the Gael overflowed from Gaul into Britain, and northward into the Kimbric Chersonesus, and southward into Italy. These fresh swarms are assumed to be the Germanic stock, who entered by the only unguarded portal between the southern spur of the Ural Mountains and the Caspian Sea, probably about 500 or 400 B.C., and found their way along the banks of the tributaries of the Vistula to the Baltic.

Intrusion of Germans by the Immigration Gate of the Volga.

Different ways by which a migratory people may enter Europe.

Besides the maritime one of the Mediterranean, it is true there are only three routes by which a great migrating horde of people could easily pour into Europe. The first leading from the plateau of Iran and the highlands to the eastward through Hamadan (the ancient Ecbatana, the capital of the Medes), through the Elvend Pass, over Kermanshah to Bagdad—the route of Alexander the Great to India—then across the Tigris and Euphrates into Asia Minor, and across the Hellespont into Europe. The second route leading from the regions of the Oxus and Jaxartes, and the remarkable table-land, opening into the western depression of the Aral and Caspian Seas, which lies between the Altai and Thian Chan mountains, is along the littoral of the Caspian, at the foot of the Elbruz mountains, to the plains of Magan, at the mouth of the Araxes, thence by the low valleys between the Caucasus and the Caspian, and across the Don and Dnieper, and into the valley of the Danube. The third, also leading from the same central Asiatic regions across the Kirgis Steppes, the Jaik, and the peculiar depression lying between the low range of the Ural, called *Obtchei Syrt*, the Caspian, the Jaik, and the Volga, and across the latter into Russia, and then going northward to the Baltic, or south-westward to the Danube. Of these routes, Dr. Wilson selects the latter, which is that almost universally adopted by ethnologists, because the others were closed, Asia Minor being occupied by Lydians, Lycians, Phœnicians, and other warlike civilized races, while the Danubian countries were

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[84] It would appear that our author assumes that not only were the Sarmatians the same as the Sclavonians, but that the Scythians and Sarmatians were also one and the same.

The route of the Germans from the Volga to Scandinavia.

in the possession of Scythian tribes. From the Volga, he supposes them to have crossed Russia "along the northern edge of the impenetrable forests of Volhynia and Poland, and the water-shed of the Dnieper and the Vistula—the route pursued by the Huns under Attila in the fifth century—and thence along the tributaries of the Vistula to the Baltic", near Livonia and Esthonia. Thence they were compelled by their neighbours and predecessors from the East, whose power had been consolidated, and who had become settled, to cross into the "islands of Gottland, Oland, and to Scania, and there settling themselves in the great northern Scandinavian peninsula, where archæological research[85] proves them to have displaced an older Allophyllian population, they nursed their young strength, preparatory to their intrusion on the historic area of ancient Europe".

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[85] In the very next paragraph (p. 44), Dr. Wilson mentions the kind of archæological investigations which he considers confirmatory of the conclusion which he has advanced, relative to the late arrival of the Germanic Nomades in Western Europe. This is "the abrupt transition from the aboriginal stone relics, to the evidences of the metallurgic arts of the last pagan period, disclosed in the sepulchral depositories of Northern Scandinavia". The effect of prejudice in diminishing the power of critical judgment in man is really remarkable. The Neo-German School having decided in their own minds that all great discoveries, both abstract and practical, belong chiefly to the Germanic branch of the Indo-European race, of course the discovery of metals must have been made by them, and was, therefore, carried into their new settlement in Scandinavia! What if the German Nomades were ignorant of iron, and only learned its use in Scandinavia, or on their way thither! Yet such is, very probably, the case. The idea that three successive races occupied the north and north-west of Europe, the first of whom used only weapons of stone, the second bronze weapons, the third, being acquainted with iron, originated, I believe, in Denmark. In an excellent little guide to the ethnological archæology of North Europe, published by the Society of Northern Antiquarians of Copenhagen, having the title of "*Leitfaden zur Nordischen Alterthumskunde. Kopenhagen.* 1837", this hypothesis is stated, as it ought to be, with caution and reserve, and merely as a probability. Some of the members of that body have not imitated this good and scientific example; among others, Mr. Worsaae in his "*Dänemarks Vorzeit durch Alterthümer und Grabhügel beleuchtet. Kopenhagen*, 1844", looks upon the hypothesis as an expression of facts. Another and more recent writer of the same school is Mr. Axal. Em. Holmberg, who has published a popular exposition of the ancient condition of Scandinavia, under the title of "*Nordbon under Hednatiden. Populär Framställing af våra Förfäders äldsta Kultur*, 1854", in which the first part is devoted to—1. The Stone Age. 2. The Bronze Age. 3. The Iron Age, etc. Another work on the same subject, but which we have not seen, is *Fr. Klee. Steen-, Bronce-og, Jern-Culturens Minder, efterviste fra et almindelig culturhist. Standpunct i Nordens nuværende Folke-og Sprogeiendommeligheder.* 1854. That weapons composed of the three kinds of materials mentioned are found in tumuli, not only in Scandinavia, but also in Ireland and elsewhere in North Europe, is true; and this is just the whole amount of truth in the hypothesis—the three successive races, each in a distinct state of cultivation, being an interesting creation of imaginative archæology, which has found favour not only in the country of its birth, but in England, Scotland, and we may also add, Ireland.

Incursion of Germans from Scandinavia into central Europe.

From the Scandinavian peninsula, he then supposes the Germanic race to have issued at a later period, and produced those grand disturbances which ended in the destruction of ancient civilization. Beginning by the displacement of the Kymri from Denmark, they seized upon the centre of Europe, from the Rhine to the Elbe, penetrating like a wedge between the Gauls and Sarmatians, causing a Keltic wave to flow over Central Italy on the one side, and into Britain on the other; and thus intruding the Gallic Cantii, Belgæ, etc., upon the older Keltic races. The pressure of the same Germanic wedge drove another part of the Kelts down the Danube, where they mingled or displaced the Illyrian and Thracian occupants already as early as the time of Alexander the Great. At a later period the Kelts invaded Macedonia and Ætolia under Brennus, and even attacked the Delphic Shrine; some also crossed into Asia Minor, where they peopled Galatia; the displacement of one race disturbing the eqilibrium of the whole chain of races throughout Europe and Asia, until the entire were set in motion, and finally poured as a vast torrent upon the Roman Empire.

Such, then, is the Indo-European hypothesis in the form in which it has assumed the greatest degree of consistency and development, by having attempted to add to the physiological and philological, the more definite and sure test of history. Taking this remarkable hypothesis as our basis, we hope in our next article to be able to investigate the problem we have in view—namely, how far have these migrations, if they are correctly stated, left recognizable traces in the languages and mythologies of the existing nations of Europe and Asia, as well as the general subject of the influence of physical circumstances upon the intellectual developments of mankind. We shall then also have an opportunity of making some observations upon the opposite theory of Latham, in which he denies the eastern origin (in the sense of the Indo-European hypothesis) of all the European nations.

W. K. SULLIVAN.

[*To be continued.*]

Art. III.—*Structural Characteristics of the Basilicas.*

THE buildings first used by modern society for the special purpose of what was a new worship, were the Basilicas. These buildings were no new invention, nor, on the other hand, were the Christians for the first time collected for worship within them. The basilicas existed under the Empire, and the new society had its meetings in small oratories or private houses, whenever the frequent outbreaks of persecution did not force its members under ground. Of the origin of the title Basilica there are several accounts, and the matter is of little importance except as indicating the use of the buildings so termed. Our modern Exchanges seem to come nearest to them, both in form and use, having both a large central space for walking and business, with covered walks or alleys by its side for the special resort of distinct traders or dealers. Besides this, the basilicas were halls of justice, and the recessed space at one end, termed tribune, was the court, with the seat of the judge raised against the centre of its wall, and benches for his assessors, and sufficient space in front for pleaders, and so forth. The side naves or walks were separated from the open centre by colonnades, which, in more splendid buildings, supported galleries appropriated to spectators, the sexes being separated. This is the outline of the basilica in its old state. It was roofed, at least in most instances, with the flat roof raised on coved sides, and thence termed *testudo*. There was nothing to compare to it among the existing buildings of antiquity for the uses required. Whether, however, these actually existing halls were permanently converted into cathedrals and churches is questionable. They were so used, doubtless, and formed the model for the ancient churches still preserved to us.

Origin of the Basilica. Its name and use.

There is a great deal to be said about the basilicas, not only in the way of very curious and interesting description, but on the principle they exemplify of adapting existing buildings, or existing models or notions of buildings, to purposes of worship, and of their other principle, of the taking no account of their exterior in comparison with their interiors.

Principles they embody.

They may be viewed, too, as the grandest examples of

Colour. decoration in colours that modern architecture has produced, and in many other respects.

It must suffice, for the present, to take a sketch of the various forms, developments, and modifications of these buildings, under their leading structural characteristics. Structure. Under this term basilica, we must include a class of buildings not always so named, which involved developments or additions that became the germs of great and wonderful features in the architecture of the greater periods, indeed of the greatest period, of modern art.

The basilica proper is an oblong building divided into three or more naves, the central being the most important, by colonnades, with a raised tribune, a sort of semicircular alcove, called the absis or apse (from the Greek ἀναβαίνω). This apse is separated from the naves by a wide transept running across the whole building, and generally extending beyond its limits of width, and spanning the central nave by a vast arch, called "triumphal". The apse exactly corresponds to this great arch, and sometimes chapels have grown in the back wall of the transept, corresponding, in like manner, to the arches opening into the side naves, so as to end the vista of all the colonnades with these recesses and altars. In the 1. The Basilica proper. earliest churches, however, altars were less abundant than now, and the central apse was the only one existing. Sometimes the side naves were double on each side (as in San Pietro), forming five with the central nave. Still the basilican oblong form remains in them all. The galleries, however, are not found in the earliest basilican churches. Coins remain which afford a rude representation of the great Ulpian basilica of Trajan, and from this one would gather that the galleries extended all along above the colonnades from end to end in that building. If so, the earlier churches built after these models omitted that feature, and raised the walls of their central nave on arches, or colonnades with flat architraves, under which access was given to the side naves. These naves, with the transept, apse, and raised tribune, under which was a subterranean chapel or "confession", in which the tombs of the saints were deposited, tombs which fixed the site of the church, formed the leading structural features of the basilica proper.

Besides this kind of structure, we have round and 2. Other forms. domed buildings, all variously taken after ancient models, particularly the Pantheon and the domed vaults of the larger thermæ at Rome, which must be considered under the same general head. Though these circular buildings, with their developments of cruciform naves, involve great changes, and principles of construction far more subtle than any needed for the basilica proper, yet they belong to the age and grow out of the others, or are found parallel to them in an unbroken tradition.

The same spirit seems to have reigned over the architecture of these first eight or nine centuries of our era, and basilicas, whether Byzantine or Roman, were from a common origin—the monuments of the old Empire. In tracing this connection, we shall be led to consider all the varieties of structure belonging to this serious and imposing style of architecture, which indeed, taken as a whole, it may be doubted whether the grand system of the Lombards and Normans, or the romantic science of the Northern Gothic, surpassed in impressive effect, capacity, and convenience.

First growth.

The first growth made in basilican building, was, as already observed, the transept, which pushed back the apse. To one side, that of the entrance, was attached a square cortile, with open colonnades round, and sometimes a fountain in the centre. In the larger basilicas this seems to have been general, but few of them have survived the changes of so many centuries. This roomy court surrounded by dead walls, was familiar, from the accustomed arrangements of the Roman dwelling-houses of the more important class. It is still traceable in the mosque of Sta. Sophia of Justinian at Constantinople, the churches of San Vitale at Ravenna, San Clemente at Rome, Sant' Ambrogio at Milan, and other churches of the first nine centuries. It has disappeared from all the great basilicas at Rome, though we may take the double colonnades of modern St. Peter's as the representative of that of the ancient building.

Baptisteries.

The Romans attached distinct baptisteries to their churches. These generally followed the type of the existing circular buildings, from their obvious applicability. That of St. John Lateran, though altered, is still the same in main lines and parts that was built by Constantine, and in which he was said to have been baptized by Pope St. Sylvester. It is octagonal, and consists of an octagonal colonnade supporting a massive architrave, from which rises a second, supporting the octagonal roof. The lower colonnade is surrounded by a wide passage or aisle for spectators. The centre descends by steps into the font.

Sta. Costanza, etc. The contemporary church of Sta. Costanza was built for a similar purpose, and was used for the baptism of the imperial family, who were buried in the great porphyry sarcophagus for merly placed in it, but at present in the Vatican gallery. The form of this church is still more elegant. It consists of a circular colonnade of arches on coupled columns, surmounted by a vaulted dome and surrounded by a vaulted aisle.

Their prototypes. On the same model were built the round church of Nocera and the circular church near Bonn on the Rhine. These were either directly on the plan, or mere modifications, of the circular aulæ of the baths, such as those of Diocletian, three of which still subsist. One forms the parish church of San Bernardo, and another, smaller, was incorporated by Vanvitelli into Michael Angelo's adapted church of Sta. Maria degli Angeli, that of the Carthusian Fathers. These are well constructed vaults of brick. The Pantheon, older than any of them, being so vast and massive that it was only the gigantic mind of Michael Angelo that has since conceived the idea of rearing such a mass into the heavens on piers and arches

San Stefano. Another circular church—that of San Stefano on the Cælian, said to be an ancient building—is larger than any of these, excepting the Pantheon, but less scientific. It is surrounded by an aisle, but the central part is traversed by walls on which an ordinary timber roof is supported. It was, however, too large and important to serve merely the purpose of a baptistery.

Galleries. Church architecture in Rome made little progress as to type and form beyond this point. Galleries, a marked feature in the basilicas of a more Byzantine character, are rare in Rome itself. Though a requisite in Constantinople for the use of women, they are not to be found in the early basilicas of Rome, or with few exceptions. That of St. Agnes is of the earliest age; but the fact of that church being built in the Catacombs, and, therefore, several feet below the surface of the ground, may have suggested it. The galleries surround the church on three sides, and are approached from the ground level. A very curious old church, called that of the Quattro Santi Incoronati, has also galleries on its two sides, ending abruptly at the altar end, so as to leave a regular basilican transept between nave and apse; the galleries and their colonnades performing the part of the walls, which usually divide the great basilicas and support their roofs. This church is perhaps the most direct representative of the actual basilican hall of the old empire, as to its galleries, in existence.

Byzantine growths.

By degrees, however, the rival capitals of Constantinople and Ravenna rose into importance as homes of art as well as seats of government. Their origin, as such, being Christian, they were, naturally, uninfluenced by the presence of a grand antiquity, with vast and various monuments of its power and activity. They received in the first instance a certain capital of ideas from Rome. In the case of Constantinople, its founder did all in his power to impart to it an artistic activity, and imported or constructed whatever he could to give it splendour and prestige. Here, as his mother, St. Helena, did in Palestine, he built basilicas, probably both on the Roman model, and that more interesting system to which the adoption of domed constructions in his capital naturally led. While ancient Rome adhered to, and has still retained its affection for, that element of length and simplicity of form which marks almost all its churches, the subtle Byzantines imbibed a deep attachment to the more scientific system of the dome, and the graceful circular colonnades and vaults which Constantine had made use of in the baptistery of Sta. Costanza. These arrangements present to the eye a certain variety and complexity of curves, and suggest to the mind a corresponding mystery, which the Orientals did not fail to dwell upon with inexhaustible delight, and to develop with a graceful, creative sense of beauty, which in its turn, and at several epochs, reacted upon the west.

Ravenna. Its style of Sculpture.

Proceeding first to Ravenna, we find, in the churches of St. Apollinare in Chiasse, the old station of the imperial fleet, and in some of the remains still existing of the episcopal palace, genuine remains of the times of St. Peter Chrysologus, magnificent monuments of the Roman basilica, with its mosaic decorations, and with the graceful development of a style of sculpture original and most characteristic. In Rome, where temples and thermæ lay in splendid and massive ruins on every side, the founders of churches had no need to quarry columns, nor to sculpture capitals or cornices. They had these ready to their hand. The consequence of this facility was, not only that the shafts were ancient, but that the capitals were taken *undecunque*, and where one or two shafts were of unequal length with the rest, the height was compensated by a foot of base or six inches of capital. These are constantly varying, when taken from older buildings, and where they were supplied for the occasion, the old forms were generally followed unchanged. In Ravenna, though both in that city and in Constantinople the emperors helped themselves to such precious shafts as were worth a sea voyage, the architects originated capital and cornice decorations for themselves. The general character of this sculpture, though far ruder than that of the empire in execution, is interesting from its simplicity and originality. The acanthus-leaf capital is still used, but with a greater desire to appreciate its natural beauty, and with a certain delight in observing the fresh joyousness of living vegetation, blown by winds, and clinging round the convex mass, rather than gummed on to it in the old Corinthian manner. The convex form, as naturally indicative of the greatest sustaining power, is preferred to the old concave in capitals. This character of detail appears in the oldest of these Ravennese churches.

San Vitale.

But Ravenna has some remarkable monuments of the age of Justinian and of Galla Placidia. The most important of these is San Vitale, an octagonal building rising into a dome and surrounded by a wide vaulted aisle, with a gallery above it, also vaulted. The arches on which this central dome rests are supported on massive piers, and rise to the height of the top of the upper galleries. Seven of these arches thus open into the gallery and aisle by a semicircular recessed colonnade, in two stories, falling into the arch above by means of a semidome and vault. The eighth side protrudes into a sanctuary that interrupts the circuit of the aisle and gallery, and ends in an apse beyond the octagonal outer wall. The roof of this portion of the church is a quadripartite vault of masonry, covered with mosaic. That of the apse is as usual

Its portico.

One feature common to all basilicas, that of the portico, appears in great beauty in churches of this description, and particularly in this of San Vitale. It is a wide enclosure, attached to one of the angles of the outer walls, enclosing, therefore, two narrow triangular spaces, which seem to form with the actual portico a double enclosure. There are openings into these spaces by means of arches; but the walls are not cut away into regular colonnades between them and the aisle of the church.

S. Giovanni in Fonte.

Other domed octagonal churches at Ravenna are also of great interest. One of these, S. Giovanni in Fonte, is octagonal, and formed once the baptistery attached to the cathedral. A road now runs between the two. It has a raised font of marble in the centre, instead of the octagonal basin sunk in the baptistery of Constantine. This font, like that of the baptistery of Pisa, is large enough for immersion. The dome rests on the outer walls.

Structure of domes with pots.

One very remarkable feature in the dome constructions that were now building is the masonry of the dome itself. That of San Vitale consists of cylindrical pots screwed into each other, the tail of one made to fit into the mouth of the next. These are then carried round in a close spiral, like the structure of a straw beehive. Brittle as these earthen jars may seem, few constructions can be stronger, consistent with the lightness required, the cylindrical form of the jars, coupled with the extra strength of the doubled portions where the tails are inserted at regular intervals, being a full equivalent for the non-solidity of these voussoirs.

In monolith.

Another of the domed churches of Ravenna, somewhat later in date, must be noticed as a curious example of the very contradictory of such a system of construction. This is the church called Rotonda. It is circular, or rather polygonal with the effect of being circular. It consists of a very solid cruciform vault in the basement, into which the sea water has access. Above this rises the polygonal chamber, surrounded by a vaulted gallery, which was (for it is no longer existing) completely external to the main chamber, and only entered from it by two or three openings. The dome that covered the centre is of one single stone, hollowed out and cut externally into a bold convex, leaving massive stone handles, hollowed under, by means of which it was raised to its position. Against the outer surface of each of these stood, it is said, the image of one of the apostles. There is no trace of them now, the vault of the surrounding gallery having been destroyed. What is most curious about this enormous mass of stone, weighing 2,280,000 pounds in its rough state, and 940,000 pounds at present, is that it must have been the first stone of the building. It is quite inconceivable that, after the raising of the walls to the requisite height, such a mass could have been first raised and then moved by machinery wide enough to embrace the building and drop its roof upon it. The only reasonable explanation of it is that the stone was raised and held aloft by scaffolding till the walls rose and received it. As a *tour de force* it is a wonderful testimony to the energy and vigour of Theodoric the Goth, who had it made to support the porphyry sarcophagus he was buried in, which the traveller may now see attached to the front of his palace in one of the streets of Ravenna.

Tomb of Galla Placidia.

The Empress Galla Placidia has left us one of the most interesting of yet existing basilicas. It is very small, scarce forty feet in greatest length, cruciform, of the regular Latin proportions, and rises into a little dome at the intersection. The whole is vaulted in very massive masonry, and beautifully encrusted with marbles and mosaic. It was made to contain three heavy sarcophagi, for which there is just room in the three smaller arms of the cross. The central contains the remains of the empress herself; the others those of Honorius, her brother, and Constantius, her second husband. The body of the empress was preserved in full dress, sitting in a chair, down to the sixteenth century. It could be seen through an opening in the sarcophagus. Unfortunately, some children put into it a lighted candle, which caught the dress, and the whole was consumed. The opening is closed up, but how much of her imperial majesty may still remain unconsumed cannot be known. There remains, too, in this curious church a primitive altar. It stands under the cupola, is of the usual height and proportions, rather short, and stands on a single step or footpace. The whole is composed of slabs of white marble. That which forms the front is rudely sculptured with a cross, a lamb, and a dove, in low relief. On the altar is a small predella to hold the candlesticks: whether this forms part of the original may be doubtful, but the whole is a rare specimen of so small an altar in its ancient state.

San Lorenzo, Rome.

Some of the imperial magnificence found its way into Rome in the form of the interesting basilica of San Lorenzo Fuori le Mure. It is the only basilica of the large class in Rome in which galleries are found. The present building has been much altered. The church of Galla Placidia, built in the fifth century, was to some extent rebuilt by Pelagius the Second, in 578; but the old columns either remained or were replaced and twelve fluted columns of pavonazzo enclose the sanctuary on two sides, and a third colonnade on the third. Above the side colonnades, which were half buried till they were opened twenty-five years ago to their bases, are galleries, with smaller columns of pavonazzo and serpentine. The burial of these lower columns seems to indicate that they and the galleries above them were of the original work of the empress, as it is not probable that freshly placed shafts should be buried in a new building. The restorations were of other parts of the church. The present nave was added in the eighth century by Adrian the First, who reversed the original arrangement, placing the opening of the nave where the apse had formerly stood. The raising of the ground in the present sanctuary has been occasioned by the height of the subterranean chapel containing the bodies of SS. Stephen and Laurence, and the level of both sanctuary and side aisles under the galleries was made to coincide with the top of this vault. If this was the work of Pope Pelagius, it accounts for the remarkable position of the columns in this older portion. It would otherwise obviously have been easier to cut the shafts than to go to the trouble of burying them to diminish their height.

The architecture of Galla Placidia and of Justinian made no more progress than this in Rome. In the east, however, the emperor achieved greater wonders even than in Ravenna. He determined to rebuild the church of Sta. Sophia, founded by Constantine, and found too small for the importance of the later city. Justinian had good reason for desiring to recal to the memory of his subjects his predecessor's object in its foundation. The present church, or mosque, is in plan a square enclosure of 269 feet by 243 diameter, of massive walls. This is subdivided into nine portions, the central being the great dome, from which radiate four arms of a cross, or four naves of equal length, and enclosing four square spaces in the four corners. The eastern and western arms of the cross are wider than the other two. They are formed by two semidomes of the same diameter as the dome, opening out from the base of the latter, and thus prolonging it into a vast oval hall. The northern and southern transepts are in stories, as are the four angular enclosures. The transept galleries and lower stories are subdivided by the two tiers of columns necessary to

Sta. Sophia, Constantinople.

support the vaulting and floor above. These four vast piers, on which the dome rests, with the eight corresponding piers in the outer walls, on which the various arches abut, which form the plan of the church, form so many admirably calculated points of support, and the connecting arches form them into eight enormous buttresses, sufficient to resist the lateral thrust of this bold cupola. It is the shallowest in existence for its enormous span of one hundred and fifteen feet; the depth being only equal to one sixth of this diameter. The height of the centre is no less than one hundred and eighty feet above the floor. It is lighted at its base by a circle of twenty-four arched windows. The interior presents to the eye the appearance of an oval vault descending on piers and arches, subdivided into arcades in two tiers. The eastern and western semicircles enter the angular enclosures of the square by semicircular recessed colonnades in two tiers, as in San Vitale, and the altar end protrudes into an elongated apse, which passes beyond the boundary walls, those on the east being made thick enough to enclose small chambers for various purposes, while the western subdivisions open by nine arches, three in each subdivision, into the vestibule, an inner gallery running the entire breadth of the building, and opening again by four arches into a broader portico, to which there are three doors, protected by three small external porches. Towers and staircases flank this double portico, and there are four square staircases, *en cordon*, for the ascent of mules or horses into the galleries. Justinian's predecessors had rebuilt the church once since its original foundation, and it had again been destroyed by the same means as in the first instance, viz., by fire. It was necessary, therefore, to construct the building of fireproof materials. The dome seems to be strengthened (according to Gibbon) by circles or chains of iron, the piers being of solid blocks of freestone. The weight of the cupola is diminished by its material, which is Rhodian brick of peculiar lightness. Unfortunately, the building was scarcely complete before a large portion of it was thrown down by the shock of an earthquake, a misfortune more common in that latitude than it has been since. The Emperor Justinian was not discouraged, but entirely restored it, strengthening the mass of the external piers, so that no settlement has taken place since. Like almost all the public buildings of the later empire, this was constructed in brick and crusted over with mar-

Its dome.

ble and mosaic. Confining ourselves, however, for the present to the structural character of these churches, we shall find that this type, once reached in Constantinople, began to spread in every province of the Greek empire, and to find its way further still, into India and Syria. In no long time the Mahommedan sect arose, grew, and propagated itself with fearful success and celerity. This dome construction was taken up by it, and Sta. Sophia became the type of the Arab architecture, destined some five centuries later to react upon that of the west, imparting much of its oriental elegance to the Norman and Frankish builders. Nine hundred years after the foundation of Sta. Sophia, the Turks were masters of that church, and followed it out in three or four magnificent mosques, those of Achmet and Suleiman being more scientific and graceful, though scarcely more solemn or impressive, than their original. With Sta. Sophia, however, San Vitale, San Nazzaro è Celso (the tomb of Galla Placidia), and the great churches of Rome, we must limit the class of buildings which are to be included under the head of basilicas.

Becomes a type of Oriental architecture.

Mosques after its model.

Something more must be said about the state of decorative art during the period of their erection, and the mode in which it was applied to their ornamentation. The material of these buildings was in general brick; and for a kind of masonry, then only valued for its superior cheapness and utility, none ever was more accidentally sublime. That kind of work, of which traces still remain of the age of Honorius in Rome, called *reticulatum*, had gone out of use. It consisted in the facing of the mass being laid end ways, the bricks being square on the facing, and diminishing within so as to set in like teeth. The brick of Justinian's time, and commonly used in the basilicas, is the old, dark red, large, flat brick, a foot and a half long, with bands of large tile introduced, and arches turned in the same material. The quantity of mortar used, and the proportion of surfaces on which it fastens, form the secret of the extraordinary solidity of this mode of building. The walls and vaults become shells of solid rock. The campaniles, or bell towers, attached to the basilicas, usually distinct from them, are built round at Ravenna, elsewhere square, but without buttresses like our northern towers. The construction, then, of these churches being thus simple and solid, is usually left to speak for itself externally. As architec-

Decorative art of the Basilicas.

ture, the basilica builders had no sort of intention of challenging critics in their exteriors. They contemplated art in their interiors only. This was by a system of decorative incrustation. Very rarely had they the means, or did interest for the mode of building subsist a sufficient number of ages, to see this incrustation carried out to the exterior surface. The one great exception of St. Mark's at Venice, must be noticed separately. This mode of decoration was intended for the interiors. Mosaic of small dice or cubes of coloured marbles had been extensively used, chiefly for pavements, but also for roofs, by the old empire in later days. The incrustation of walls with larger and more magnificent veneers of marble was also common. The scale on which the imperial baths and palaces were built, necessitated the use of the more cheap and procurable material of brick; and the taste for importing rare and splendid marbles, could only satisfy itself by covering with them these vast protected interior surfaces. This system therefore became, in the hands of the rich and luxurious Romans, the most sumptuous source of architectural decoration. It was at the same time a system distinct from that of the structure itself. The latter was crusted over and concealed as by a coat, the forms and lines of which had no necessary connection with the mass beneath or behind it. These slabs of marble were usually made to cover the walls up to a given height, fifteen to twenty-five feet, after which occurs generally a string or cornice holding them and binding them into the wall, while it marks the division between the marbles and the mosaic decorations, which, being in small dice, could assume the character of pictorial representation. The sculpture on these buildings is usually executed in white marble, the shafts of columns being of various colours and monoliths. As already observed, there are two characters of sculpture in basilicas, the first being a simple imitation of the debased Roman work of the period, and usually executed to supply parts that were not to be obtained by ransacking the ruins of the city. The second period of sculpture, viz., all that executed in Ravenna, Constantinople, or elsewhere, where no older work was at hand, has a character of its own—sharp, severely controlled, but not wanting in vigour or grace. Constantinople and Ravenna furnish the most elegant and characteristic work of this kind. In this sculpture natural forms and the

Incrustation.

Sculpture.

appreciation of natural vegetation begin to reappear. For some ages the easterns seem to be ahead of the west in these respects; the east therefore will form the best field for study for details of these works.

Decadence of ancient art.

The state of artistic design was undoubtedly at its lowest when these basilicas began to be erected as churches. Their historical designs are rude and conventional. The old Greek sense of beauty had died out in Rome. Luxury and vulgarity had gradually destroyed the manliness of the race, and such sense and love of beauty as it had possessed in days of vigour and prosperity. Constantine could find few competent artists either to sculpture his triumphal arch or to decorate his new capital. Still the Christian community had carried down with it into its subterranean oratories and chapels certain traditions of former times. Historical representations, even sometimes under mythological types, as that of Orpheus, are habitual to those interesting monuments. The classic tunic, and occasionally the nude figure, continued to be represented in their paintings. We shall find, as basilica building and decoration progressed, a marked difference between the simplicity of accessories of dress and ornament in the west, in contrast with the elaboration of colour and detail in the east. The basilicas of Justinian at Ravenna are interesting examples of this Byzantine spirit. They represent in more than one instance the emperor and his court, or his empress and hers, with details of costume carefully followed. But though these designs were rude, and showed ignorance of form, they were by no means wanting in grandeur. Quite the contrary. That nerve and vigour of character which luxury had eaten out of the Italian character, was beginning to grow anew from fresh sources, and Christianity really inaugurated the revival of the arts. That revival was slow, and conducted through most stormy ages of calamity, but a genuine revival it was. The peculiar changes of personal character which Christianity gradually spread, till it affected races and nations, often, probably to keen observers always, expresses itself in that index of the human soul, the face. Whether the early races of believers philosophized upon this fact or not, they were undoubtedly affected by it. It grew into an instinctive principle, that the face was the field, in man, for expressing character. The power of representing action or motive was therefore sought in the ex-

Its revival under Christian influences.

Study of the human face in preference to the figure.

pression of the features, rather than the position or movement of the limbs. And though, of course, it was centuries before the refinements of art in representation of these objects could be attained, still some influence of the kind is observable in these early Christian representations, and, though rude, the faces and forms possess a grandeur which no art, with all its charm, has since surpassed; purpose, position, and architectural character of the representations being taken into account. Mosaics of glass, with gold ground or deep blue, worked in the same manner and material, were the means at the disposal of the architect for decorating all those portions of his church which either could not be covered with marble, or fell into the lines of curve or concavity caused by the arches of the roofs, domes, semidomes, and colonnades. We have alluded already to Venice. What marks so peculiarly the interest of San Marco, is its preservation of the basilican type after so many ages, with the additions of length from its western, and domes from its eastern associations. It is, besides, both decorated from pavement to keystone in its interior, and elaborately on its visible exterior portions besides. It exhibits the refinements of mosaic decorations both in historical subjects and their accessory details, and besides in decorations of borders, inlaid cornices, and the like. As to its form, we can only stop to give it generally. The church is small; its outline is a Latin cross covered by five domes; the eastern arm running into apse besides, and the western having the addition of the portico or vestibule running the entire width of nave and aisles. These aisles continue throughout the building. They are divided by arcades, which are not vaulted, but open at top, from the nave. They are covered above by the ponderous arches which support the sides of the domes, and are wide enough to bridge over the corresponding portions of aisle width lengthwise. The outer porch is vaulted, and rises to about half the height of the western façade; it opens by five arched doorways to the outer air. The front of this therefore forms the lower facade of the church, and the arches of the doorways rest on two tiers of columns of marble of all colours, the archivolts being of sculptured white marble. The columns are continued along the front with great effect, and, as in the basilicas, are monolithic. The pavement of San Marco is an admirable example of almost every kind of

San Marco, Venice.

marble mosaic, from the Roman and Alexandrian work down to the medieval Italian pietra dura. The Venetians had peculiar facilities for such modes of building, and were much under Greek influence while holding the key of the central waters of Europe. A detailed account of St. Mark's would require more space than we can now afford. But though so much later than the early basilicas, it is a wonderful exponent of their principles.

It remains, before concluding, that some comparative notice should be taken of the scale of the old basilicas, with reference to the larger churches of subsequent times.

Comparison of scale with subsequent buildings.

	Length.	Total width.	Length of transept.	Height.
	Feet.	Feet.	Feet.	Feet.
San Paolo, in Rome, is in extreme length,	419	214	279	120
Sta. Sophia, the largest of the Byzantine churches,	269	243		180
WITH THESE COMPARE				
The modern St. Peter's, Rome,	669	395	442 Cupola, 139	432 (Cupola and lantern). Church, 146
Sta. Maria dei Fiori, Florence,	454		334 Cupola, 133	Cupola, 387 Nave, 153
Cathedral of Cologne,	500	280	290	200 Towers, 500
" Amiens,	444	84	194	141
" Old St. Paul's, London,	500	91	248	102 Spire, 534
" Winchester,	545	86	186	178
Duomo of Milan,	490	197	295	Spire, 400

It will be seen, indeed, from these few instances, how greatly the elements of length and height increased in after times. That of cubic capacity, on the contrary, seems to have diminished. If we deduct from the medieval churches the parts walled off by solid stone screens or wooden partitions, and the immense space taken up by the piers necessary for the support of vaulted roofing, we shall see how decidedly the older buildings have the advantage, as far as the question goes of holding vast multitudes at a time. A simpler arrangement than that of the western basilica can hardly be conceived, and, graceful and wonderful as the subsequent architecture became in southern as well as northern Europe, no buildings whatever have surpassed these early churches either in solemnity or practical convenience.

John H. Pollen.

SCIENTIFIC RESEARCHES.

ART. I.—*On the Influence of the Great Inequalities of Jupiter, Saturn, etc., upon the Motions of the other Heavenly Bodies.* *By* REV. W. G. PENNY.

The product of the disturbing forces of two planets causes inequalities of long period.

IN calculating the amount of the perturbation in the path of one planet caused by the action of another, it is usual to assume that both the planets would, except for the inequalities caused by their mutual attraction, move accurately in ellipses, no account being taken of the small inequalities in the path of either of them caused by a third planet. But since in reality any alteration in the place of either of them causes an alteration in their mutual distance, it is evident, according to the theory of gravity, that their mutual attraction will be altered also; that is, that their disturbing force will be different; or in other words, that a new disturbing force will be added, which will produce its corresponding inequality in the path of each of them.

Now, the undisturbed place of a planet so nearly coincides with its actual place, that we may in most cases altogether neglect any difference in the disturbing force which arises from the planet not being exactly in the place where it would be if undisturbed; but we cannot do so always. For example, in the case of Saturn, there exists an inequality in longitude which is represented by $652'' \sin (2n_4t - 4n_5t + \Pi)$, together with another of about half the magnitude of the radius vector. These, in linear measure at least, are about equal to the eccentricity of the Earth's orbit; and therefore, under certain circumstances, are quite large enough to produce a sensible inequality in the motion of a neighbouring planet.

In fact, when we remember that the effect of a disturbing force depends not only upon its intensity, but also, in some cases, upon the square of the time during which it acts in one direction, it is evident that a very minute force, if its period is very long, may produce very sensible results.

In order therefore to complete the theory of planetary perturbations, it becomes quite necessary to search out all forces of this kind whose period is very long, or in other words, to examine whether in the formation of the differential equations of motion, we may not by the employment of the *true coördinates* of the planets, find terms in the disturbing function which we should not find by merely using the elliptic ones, having a very small divisor, and which consequently will be much increased by integration. For example, suppose that we are calculating the mutual perturbations of Saturn and Uranus. Now, if we employ the terms above mentioned, which occur in the true coördinates of Saturn, it is evident that we shall obtain a term in the differential equations of motion of the form

$$\mathrm{B}\sin(3n_6t-6n_5t+2n_4t+\Pi)$$

n_4, n_5, n_6, being the mean motions of Jupiter, Saturn, and Uranus. This expression, as it will have to be twice integrated, will be twice divided by $3n_6-6n_5+2n_4$, which is a small quantity; and the term which results in the longitude of Uranus from the employment of the above mentioned and other inequalities which will produce terms of the same form, amounts to about 43 seconds. This, though much smaller than some of the inequalities in the path of Uranus, is still considerable with respect to many that occur in the planetary theory, being in fact larger than any that have been hitherto noticed in the motions of Mercury, Venus, the Earth, or Mars; and being more than five times as large as any of the perturbations of the Earth. Its period is about 1,700 years; and there will be corresponding terms in the longitude both of Saturn and Jupiter; that of Saturn amounts to about 40″, and that of Jupiter to about 10″.

Inequality of long period in

Another remarkable inequality of the kind which I have found, is one which appears to exist in the motions of the Earth and Mars.[1] Its period is somewhat longer than the one mentioned above, being about 1,800 years, or about twice that of the long inequality of Jupiter and Saturn. It arises in the following way: Four times the mean motion of the Earth is *very* nearly equal to eight times that of Mars minus three times that of Jupiter; it has an exceedingly small divisor; and in fact the term which represents it in the disturbing function is multiplied by a quantity which amounts to upwards of twenty millions! This inequality appears to amount, in the case of the Earth, to about 7.29″, and in that of Mars to about 45″; quantities which are larger, and in the case of Mars very considerably so, than any which arise from simple perturbation; the largest hitherto known in the motion of the Earth, amounting to not more than 7.15″, and in the motion of Mars to 24.53″.

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[1] Since the above has been in type, we have found that this inequality, as far at least as the motion of the Earth is concerned, has been already calculated by MM. Leverrier and Hansen. The coëfficient given by the former (see vol. xxx., p. 463, *Comptes rendus*) is 7.162″. That by the latter is 6.221″. That here obtained is 7.293″, which therefore agrees very closely with that given by M. Leverrier. Also the small inequality noticed further on, which depends on the disturbing forces of Mars and Venus, has been given by the latter writer; but not that depending upon the product of the forces of Jupiter and Saturn.

the motions of Mars and the Earth.

One remarkable thing about this inequality is the effect which it appears likely to have upon the motion of the Moon. According to the investigations of Professor Hansen, the inequality lately discovered by Mr. Airy in the motion of the Earth, which amounts to about 2.05″ with a period of 240 years, gives rise to an inequality in the motion of the Moon amounting to about 23″; and therefore it would seem that there will also be a corresponding one arising from that above mentioned, and which will amount to something considerable. I have not been able to get access to Professor Hansen's investigations, and have not yet finished the calculation of the lunar inequality, and therefore cannot as yet give its precise amount; but I hope to have done so in time to publish the results in the second number of this Periodical.

And, in general, in order to find quantities of this kind, we must not only seek out all terms in which $p_1n_1-p_2n_2$ is small, $n_1, n_2, \ldots,$ being the mean motions of the planets, and $p_1, p_2, \ldots,$ any whole numbers, but also all those in which $p_1n_1-p_2n_2\pm p_3n_3$ is small with respect to any of the three quantities n_1, n_2, n_3, for all such terms will be much increased by integration. It will be seen that all such quantities will be of the order of the second power, or rather of the product of two powers of the disturbing force. It should also be observed, that in general, if $p_2 n_2$ relate to that one of the three planets which lies between the other two, the quantity p_2 ought to have a different sign from p_1 and p_3, in the same way that where two planets only are concerned, p_1 and p_2 should have different signs; otherwise such high powers of the eccentricities will be involved as will make the terms quite insensible.

The two combinations above given, namely $4n_2-8n_3+3n_4$ and $2n_4-6n_5+3n_6$, appear to be much the most remarkable; but there are others also which give rise to quantities which come within the limit at which it is usually considered necessary that they should be retained in the planetary tables; there are even one or two such involving the product of *three* disturbing forces, and consequently the coördinates of four planets One of them appears to amount to about 7″.

With regard to this limit of the quantities which are to be considered as worth retaining, it may be remarked that M. Bouvard retains quantities which exceed a centesimal second; and MM. Pontécoulant and Laplace go still further; the former retains quantities of one-tenth of a sexagesimal, and the latter of a tenth of a centesimal second. But with respect to the terms at present under consideration, it may be quite sufficient to retain only those which exceed a sexagesimal second, except, perhaps, in the case of the Earth; where it may be advisable to include smaller ones, in consequence of the inequalities which they may be the cause of in the motion of the Moon.

Equations of motion.

To proceed then with the calculations: and first let us determine the inequality of the Earth and Mars.

$$\text{Let } R=\frac{m'r\cos(\theta-\theta')}{r'^2}-\frac{m'}{\surd(r^2-2rr'\cos(\theta-\theta')+r'^2)}$$

Where r, θ, etc., refer to the disturbed, and the quantities with the accents to the disturbing planet.

I employ the equations,

$$\delta\theta=\frac{1}{a^2n\sqrt{(1-e^2)}}\left\{d_{\iota}(2r\delta r)-\delta r d_{\iota}r+3\int_{\iota}\int_{\iota}d_{\iota}(R)\right.$$
$$\left.+2\int_{\iota}r d_{r}R\right\}$$

for determining the alteration in longitude, and

$$d_{\iota}^2 r\delta r+n^2 r\delta r=-2\int_{\iota}d_{\iota}(R)-r d_{r}R$$
$$-n^2 r\delta r\left\{3e\cos\overline{nt+\epsilon-\varpi}+,\text{ etc.}\right\}$$

for determining that of the radius vector.

In the formation of these equations, several quantities depending upon powers of the disturbing force higher than the first, are omitted; but none of these quantities omitted appear to have any effect upon the investigations which follow; so that we may use the above equations as they stand.

Then, to find an equality in longitude of the form

$$P \sin(8n_3t-4n_2t-3n_4t+\Pi)$$

Expansion of R.

we must find all terms in R having the same argument. For this purpose we must expand R, and its expansion is effected in exactly the same way as in ordinary cases where we are considering the mutual perturbations of two planets only; that is, by making it depend upon the expansion of the quantity

$$\frac{m'}{\sqrt{(a^2-2aa'\cos(\theta-\theta')+a'^2)}},$$

a and a' being the constant parts of r and r'.

This is done by assuming the quantity

$$\frac{m'}{\sqrt{(a^2-2aa'\cos(\theta-\theta')+a'^2)}}=\tfrac{1}{2}A_o+A_1\cos(\theta-\theta')+\text{etc.}\ldots$$
$$+A_k\cos k(\theta-\theta')+\text{etc.}\ldots$$

Then if we call $\dfrac{m'}{\sqrt{(a^2-2aa'\cos(\theta-\theta')+a'^2)}}$ A; it is evident that if we neglect for a moment the quantity $\dfrac{m'r}{r'^2}\cos(\theta-\theta')$, R is what A becomes when r, r', are written for a and a', or when we write $a(1+v)$ for a, and $a'(1+v')$ for a', where av and $a'v'$ represent the variable parts of r and r'; therefore we shall have by Taylor's theorem

$$R=A+avd_aA+a'v'd_{a'}A+\text{etc.}$$

Now since

$$A=\tfrac{1}{2}A_o+\ldots\ldots\ldots+A_k\cos k(\theta-\theta')$$

we shall have

$$ad_aA=\tfrac{1}{2}ad_aA_o+ad_aA_1\cos(\theta-\theta')+\ldots\ldots\ldots\ldots$$
$$+ad_aA_k\cos k(\theta-\theta')+\ldots\ldots\ldots$$

$$a'd_{a'}A = \tfrac{1}{2}a'd_{a'}A_0 + a'd_{a'}A_1 \cos(\theta-\theta') + \dots\dots\dots$$
$$+ a'd_{a'}A_k \cos k(\theta-\theta') + \dots\dots\dots$$

with similar quantities for $a^2d^2_aA$, $aa'd_a\, d'_aA$, etc.

Therefore, by substituting these values of A, ad_aA, etc., in the expression for R, and collecting the coefficients of the different cosines, we shall have for this part of R,

$$R = -(\tfrac{1}{2}A_0 + \tfrac{1}{2}ad_aA_0v + \tfrac{1}{2}a'd_{a'}A_0v' + \text{etc.}\dots)$$
$$-(\ A_1 + \ ad_aA_1v + \ a'd_{a'}A_1v' + \text{etc.}\dots) \cos(\theta-\theta')$$
$$\dots\dots\dots\dots\dots\dots\dots\dots$$
$$-(\ A_k + \ ad_aA_kv + \ a'd_{a'}A_kv' + \text{etc.}\dots) \cos k(\theta-\theta')$$
$$-\ \text{etc.}\dots\dots\dots$$

The expansion of the first part of R is effected in like manner, and it becomes $\frac{a}{a'^2}(1+v-2v'+\text{etc.}) \cos(\theta-\theta')$ so that the only part of R which will be affected by the addition of this quantity is the coefficient of $\cos(\theta-\theta')$; adding these quantities together, we may put R under the form

$$R = -(\tfrac{1}{2}A_0 + \tfrac{1}{2}ad_aA_0v + \tfrac{1}{2}a'd_{a'}A_0v' + \text{etc.}\dots)$$
$$\dots\dots\dots\dots\dots\dots\dots$$
$$-(A_k + ad_aA_kv + a'd_{a'}A_kv' + \text{etc.}\dots) \cos k(\theta-\theta')$$
$$-\ \text{etc.}\dots\dots\dots$$

And in order to obtain terms of the form

$$P \cos(8nt_2 - 4n_3 - 3nt_4 + \Pi)$$

we must substitute for v, v', θ, θ', not merely their elliptic values, but their complete values; that is, we must include all terms which they may contain which will produce terms of the required form.

Again, the most convenient form in which R can be put for reducing it to numbers is by substituting for ad_aA_k, $a^2d^2_aA_k$, etc., their values in terms of $a'd_{a'}A_k$, $a'^2d^2_{a'}A_k$, etc.[2] These are,

$$ad_aA_k = -A_k - a'd_{a'}A_k,\ aa'd_ad_{a'}A_k = -2a'd_{a'}A_k - a'^2d^2_{a'}A_k,$$

$$a^2d^2_aA_k = -2ad_aA_k - aa'd_ad_{a'}A_k = 2A_k + 4a'd_{a'}A_k + a'^2d^2_{a'}A_k,$$

etc.

The quantities A_k, ad_aA_k, etc., are also dependent upon the coefficients of the expansion of the quantity

$$\frac{m}{\sqrt{(1-2a\cos(\theta-\theta')+a^2)}}$$

where $a=\frac{a^1}{a}$, a being greater than a'; and if b_k be the general coefficent of the latter quantity, it is found that

$$A_k=\frac{1}{a}b_k,\ a'd_{a'}A_k=\frac{1}{a}ad_ab_k,\ a^nd^n_{a'}A_k=\frac{1}{a}a^nd^n_ab_k,\ \text{etc.}$$

except in the particular case where n and k are both unity, when they have a different value; but this term does not enter into the present investigation. The terms of this kind which will be wanted in the case of Mars and the Earth, are found to be as follows:—

Numerical values of quantities, etc., in expansion of R.

$b_4 = .129973$ $b_5 = .077170$ $b_6 = .046595$

$b_7 = .028480$

$ad_ab_4 = .60426$ $ad_ab_5 = .43723$ $ad_ab_6 = .31104$

$ad_ab_7 = .21184$

$a^2d^2_ab_4 = 2.4881$ $a^2d^2_ab_5 = 2.2148$ $a^2d^2_ab_6 = 1.1918$

$a^2d^2_ab_7 = 1.5318$

$a^3d^3_ab_4 = 10.267$ $a^3d^3_ab_5 = 10.527$ $a^3d^3_ab_6 = 10.431$

$a^3d^3_ab_7 = 9.894$

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[2] a' is supposed to be less than a.

$$a^4 d_a^4 b_4 = 54.72 \quad a^4 d_a^4 b_5 = 58.67 \quad a^4 d_a^4 b_6 = 60.37$$

$$b_8 = .017565 \qquad a = .6563003$$

$$a d_a b_8 = .15666$$

$$a^2 d_a^2 b_8 = 1.2259$$

$$a^3 d_a^3 b_8 = 8.701$$

Direct and indirect perturbation.

It must be here observed that the entire perturbation of any of the three planets, say of Mars, for instance, will consist of two distinct parts; first, that caused by the indirect action of Jupiter and the direct action of the Earth, and next, that caused by the indirect action of the Earth and the direct action of Jupiter. Thus, in the first case, if there are certain inequalities in the orbit of Mars produced by the action of Jupiter, the attraction of the Earth upon it will be different to what it would be if there were no such inequalities; the terms arising from this difference are what we mean by those arising from the indirect action of Jupiter and the direct action of the Earth, and so for the second case.

To find terms of the first kind, we must find all those terms in the coördinates both of Mars and the Earth which arise from the simple perturbation of Jupiter and which include the quantity $3n_4t$ in their argument; and must add them to the elliptic values of $r\ r'\ \theta\ \theta'$ in the disturbing function which relates to Mars and the Earth; and to find terms of the latter kind, we must find all terms in the coördinates of Mars and Jupiter which include in their arguments the quantity $4n_2t$. Let us begin with the former, as they appear to be the more important. I find then the following quantities in the coördinates of Mars:—

Inequalities which have to be added to the elliptic values of the coördinates of

$$\left.\begin{aligned} \delta\theta &= .201257'' \sin(4n_3t - 3n_4t + 4\varepsilon_3 - 3\varepsilon_4 - \varpi_3) \\ \frac{\delta r}{a} &= -.11505'' \cos(4n_3t - 3n_4t + 4\varepsilon_3 - 3\varepsilon_4 - \varpi_3) \end{aligned}\right\} \ldots\ldots (a)$$

$$\left.\begin{aligned} \delta\theta &= -.01101'' \sin(4n_3t - 3n_4t + 4\varepsilon_3 - 3\varepsilon_4 - \varpi_4) \\ \frac{\delta r}{a} &= .00929'' \cos(4n_3t - 3n_4t + 4\varepsilon_3 - 3\varepsilon_4 - \varpi_4) \end{aligned}\right\} \ldots\ldots (a_1)$$

Mars and the Earth in forming the differential equations.

$$\left.\begin{aligned}\delta\theta &= .02465''\sin(4n_3t-3n_4t+4\varepsilon_3-3\varepsilon_4+109°.1)\\ \frac{\delta r}{a} &= -.008955''\cos(4n_3t-3n_4t+4\varepsilon_3-3\varepsilon_4+108°.18')\end{aligned}\right\}.(a_2)$$

$$\left.\begin{aligned}\delta\theta &= 1.19503''\sin(3n_3t-3n_4t+3\varepsilon_3-3\varepsilon_4)\\ \frac{\delta r}{a} &= -.951068''\cos(3n_3t-3n_4t+3\varepsilon_3-3\varepsilon_4)\end{aligned}\right\}\cdots\cdots\cdots(b)$$

$$\left.\begin{aligned}\delta\theta &= .2623''\sin(3n_3-3n_4t+3\varepsilon_3-3\varepsilon_4+81°.27)\\ \frac{\delta r}{a} &= -.1068\cos(3n_3t-3n_4t+3\varepsilon_3-3\varepsilon_4+81°.56')\end{aligned}\right\}..(b_1)$$

$$\left.\begin{aligned}\delta\theta &= 2.3180''\sin(2n_3t-3n_4t+2\varepsilon_3-3\varepsilon_4+50°.6')\\ \frac{\delta r}{a} &= -1.4776''\cos(2n_3t-3n_4t+2\varepsilon_\varepsilon-3\varepsilon_4+52°.43')\end{aligned}\right\}(c)$$

$$\left.\begin{aligned}\delta\theta &= .195''\sin(2n_3t-3n_4t+2\varepsilon_3-3\varepsilon_4+20°34')\\ \frac{\delta r}{a} &= -.0889''\cos(2n_3t-3n_4t+2\varepsilon_3-3\varepsilon_4+20.57')\end{aligned}\right\}\cdots(c_1)$$

$$\left.\begin{aligned}\delta\theta &= 3.3273''\sin(n_3t-3n_4t+\varepsilon_3-3\varepsilon_4-1°.14')\\ \frac{\delta r}{a} &= -.864''\cos(n_3t-3n_4t+\varepsilon_\varepsilon-3\varepsilon_4-6°.18')\end{aligned}\right\}\cdots\cdots(d)$$

$$\left.\begin{aligned}\delta\theta &= .1112''\sin(5n_3t-4n_2t+5\varepsilon_3-4\varepsilon_2-\varpi_3)\\ \frac{\delta r}{a} &= -.0942''\cos(5n_3t-4n_2t+5\varepsilon_3-4\varepsilon_2-\varpi_3)\end{aligned}\right\}\cdots\cdots(e)$$

and in the coördinates of the Earth there occur the terms

$$\left.\begin{aligned}\delta\theta' &= .16985''\sin(3n_2t-4n_4t+3\varepsilon_2-3\varepsilon_4)\\ \frac{\delta r'}{a'} &= -.135103''\cos(3n_2t-3n_4t+3\varepsilon_2-3\varepsilon_4)\end{aligned}\right\}\cdots\cdots(f)$$

$$\left.\begin{aligned}\delta\theta' &= .551129''\sin(2n_2t-3n_4t+2\varepsilon_2-3\varepsilon_4+\varpi_4)\\ \frac{\delta r'}{a'} &= -.3770''\sin(2n_2t-3n_4t+2\varepsilon_2-3\varepsilon_4+\varpi_4)\end{aligned}\right\}\cdots\cdots(g).$$

Of these quantities the values of $\delta\theta$ in (*a*) (*b*) (*c*) and (*e*), as also those of $\delta\theta'$ in (*f*) and (*g*), are taken from M. Pontécoulant's *Systéme du Monde*. The quantities (*d*) are omitted both by M. Pontécoulant and Laplace, and may therefore seem suspicious, but I have gone over the calculation of them twice on separate paper, and such appears to be the result. The values $\delta\theta$ and δr in a, are what result from the employment of the equation

$$\frac{r\delta r}{a^2} = -.951'' \cos(3n_3t - 3n_4t + 3\epsilon_3 - 3\epsilon_4)$$

in the last term of the equation for the radius vector, and in the term $\delta r d_t r$ in that for the longitude; and from the quantity which arises from the division of this value of $r\delta r$ by r, to obtain δr. Equations b, in like manner, are derived from the use of the terms

$$\frac{\delta r}{a} = -1.4776'' \cos(2n_3t - 3n_4t + 2\epsilon_3 - 3\epsilon_4 + 52°.43')$$[3]

and from the corresponding term for $\frac{r\delta r}{a^2}$, which is

$$-1.4717 \cos(2n_3t \ldots + 54°.12')$$

and the equations (c_1) are derived from the value of the radius vector in (d).

There will also be a minute quantity corresponding to equations (d) in the coördinates of the Earth, the effect of which I find will be slightly to increase the entire value of the inequality, but by no sensible quantity. The only term in the radius vector given by M. Pontécoulant is that in (b); that in (c) agrees pretty closely with that given by Laplace, allowance being made for the difference of the mass of Jupiter adopted by him. The others also which I have added will be found to be pretty correct, as they give values, when substituted in the equations for the longitude, which agree with the terms in longitude given by M. Pontécoulant.

The value of δr in (b), as given by M. Pontécoulant, is given in the form $\delta r = -.0000070256 \cos(3n_3t, \text{etc.})$. This is expressed not in parts of the radius of the orbit of Mars, but of the Earth, which radius is taken for unity. It must, however, before it can be made use of in the following calculation, be reduced to parts of the radius of the orbit of Mars, which is done by multiplying the right-hand member by aa, which will give

$$\frac{\delta r}{a} = -.0000070256\, a \cos(3n_3t -, \text{etc.});$$

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[3] These values of $r\delta r$ and δr were also employed in finding the term (d).

but as the quantity which finally results from the employment of this term will have to be reduced to seconds, it will be more convenient to express the right-hand member in seconds at once; which is done by multiplying it by $60^3 \dfrac{3}{\pi}$, and thus arises the quantity in (b). All the terms of δr are given in the same form.

It would somewhat simplify the operations if we were to put the quantities a, a_1, a_2, etc., into combination; but by keeping them separate, we can more easily see how much of the final result is due to each of them, and so may more easily supply any correction that may be necessary in consequence of any inexactness in the terms (a_1), etc.

The following values of the masses, mean motions, and elements of the orbits of the Earth, Mars, and Jupiter, are those which I have made use of; they are taken from M. Pontécoulant (μ is here supposed to be the mass of the Sun):

Numerical values of the masses and elements of the Earth, Mars, and Jupiter.

$$m_2 = \frac{\mu}{356354} \qquad m_3 = \frac{\mu}{2680337} \qquad m_4 = \frac{\mu}{1054}$$

$$n_2 = 1295977.37'' \quad n_3 = 689051.08'' \quad n_4 = 109256.59''.$$

$$\varepsilon_3 = 100°.23'32'' \quad \varepsilon_3 = 232.49.50 \quad \varepsilon_4 = 81.52.10$$

$$e_2 = .0168536 \quad e_3 = .093306 \quad e_4 = .0481621$$

$$\varpi_2 = 99°.30 \quad \varpi_3 = 332.23.40 \quad \varpi_4 = 11.7.36$$

also if γ be the inclination of the orbit of Mars to the ecliptic, and a_1 the longitude of the ascending node, $\gamma = 1°.50'$ $a_1 = 48°$.

Calculation of the inequality resulting from equations (a), (a_1), (a_2).

Let us begin by determining that part of the inequality which is due to the terms in equation (a).

$$\text{Let } \mathrm{R} = \tfrac{1}{2}\mathrm{R}_0 + \mathrm{R}_1 \cos(\theta - \theta') + \ldots + \mathrm{R}_4 \cos 4(\theta - \theta').$$

Now it is evident that the terms in equation (a) will produce a quantity of the required form by combination with the angle $4n_3t - 4n_2t$; the part of R therefore which we shall want is $\mathrm{R}_4 \cos 4\overline{\theta - \theta'}$. Now, by substituting for

θ its value increased by the quantity given in (a), viz.:—

$$n_3t+\varepsilon_3+\ldots+.201257'' \sin(4n_3t-3n_4t+4\varepsilon_3-3\varepsilon_4-\varpi_3)$$

we shall obtain the term

$$\cos 4\,\overline{\theta-\theta'}=\cos(4n_3t-4n_2t+4\varepsilon_3-4\varepsilon_2)$$

$$+\ 402514'' \cos(8n_3t-4n_2t-3n_4t+8\varepsilon_3-4\varepsilon_2-3\varepsilon_4-\varpi_3);$$

$$\text{also } R_4=-m'(A_4+ad_aA_4v)=-m'(A_4-\overline{A_4+a'd_{a'}A_4}v)$$

$$=-m'\Big\{A_4+\overline{A_4+a'd_{a'}A}_4.11505'' \cos(4n_3t-3n_4t$$
$$+4\varepsilon_3-3\varepsilon_4-\varpi_3)\Big\}$$

$\Big($by substituting for v the value given in (a)$\Big)$; therefore, by multiplying by the value of $\cos(4\,\theta-\theta')$ we shall have

$$R=-m'\Big(.402514''A_4-\tfrac{1}{2}(A_4+a'd_{a'}A_4).11505''\Big)$$
$$\cos(8nt,\ldots\text{etc.});$$

for A_4 and $a'd_{a'}A_4$ write their values $\frac{1}{a}b_4, \frac{1}{a}ad_ab_4$;

or $\frac{1}{a}.129973$ and $\frac{1}{a}.60426$ and we shall find

$$R=-\frac{m'}{a}.094552'' \cos(8n_3t-4n_2t-3n_4t\ldots-\varpi_3)$$

We have now to form the function $\frac{3}{a^2n}\int_t\int_t d_t(R)$, and in doing so we must be very careful in this and all other occasions of the kind, to remember which of the quantities $8n_3t$, etc., belong to the coördinates of the disturbed planets, since the quantity $d_t(R)$ means that R is to be differentiated with respect to the disturbed planet only. In this case, since the inequality (a), viz.:—

sin $(4n_3t-3n_4t-$, etc.), belongs to the coördinates of Mars, it is evident that the terms $8n_3t-3n_4t$ belong to Mars.

Let $8n_3t-4n_2t-3n_4t+8\varepsilon-4\varepsilon_2-3\varepsilon_4=\lambda$, then, bearing in mind what has just been said, we shall have

$$\frac{3}{a^2n_3}\int_t\int_t d_t(\mathrm{R})=-\frac{3m'}{a^2n_3}\frac{8n_3-3n_4}{(8n_3-4n_2-3n_4)^2}\frac{1}{a}.094552''$$

$$\times\sin(\lambda-\varpi_3)=\delta\theta$$

which may be put under the form

$$-\frac{3m'}{n_3^2a^3}\cdot\frac{8n_3-3n_4}{n_3}\frac{n_3^2}{(8n_3-4n_2-3n_4)^2}.094552''\sin(\lambda-\varpi_3)$$

or since $n^2a^3=\mu$, μ being the mass of the Sun,

$$\delta\theta=-\frac{m'}{\mu}3.\frac{(8n_3-3n_4)}{n_3}\left(\frac{n_3}{8n_3-4n_2-3n_4}\right)^2.094552''$$

$$\times\sin(\lambda-\varpi_3).$$

To reduce this to numbers, we have

$\dfrac{m'}{\mu}=\dfrac{1}{356354}$; log. $356354=5.5518817$.

$n_3=689051.08''$ $n_4=109256.59$ $n_2=1295977.37$.

$\therefore 8n_3-3n_4=5184638.87$

$$\begin{aligned}\text{log. } 8n_3-3n_4&=6.7147185\\ \text{log. } n_3&=5.8382513\\ \hline .8764672&=\text{log.}\frac{8n_3-3n_4}{n_3};\end{aligned}$$

$$\begin{aligned}\text{also, } 8n_3-3n_4&=5184638.87''\\ 4n_2&=5183909.48''\\ \hline \therefore 8n_2-3n_4-4n_2&=729.39''\end{aligned}$$

$$\begin{array}{rl}
\log.\ n_3 = & 5.8382513 \\
\log.\ 729.39 = & 2.8629598 \\
\hline
& 2.9752915 = \log.\ \dfrac{n_3}{8n_3-3n_4-4n_2} \\
& \qquad\quad 2 \\
\hline
& 5.9505830 = \log.\left(\dfrac{n_3}{8n_3-3n_4-4n_2}\right)^2 \\
\log.\ 3 = & .4771213 \\
& .8764672 = \log.\dfrac{8n_3-3n_4}{n_3} \\
\hline
& 7.3041715 \\
\text{subtract } \log.\ 356354 = & 5.5518817 \\
\hline
& 1.7522898
\end{array}$$

$$= \log.\ 3\,\frac{m'}{\mu}\,\frac{8n_3-3n_4}{n_3}\left(\frac{n_2}{8n_3-3n_4-4n_2}\right)^2.$$

As this multiplier is common to all the terms which occur in the direct perturbation of Mars by the Earth, it will be very useful. Adding to it the logarithm of .094552, (the remaining part of the multiplier of sin $(\lambda-\varpi_3)$) which is

$$\begin{array}{r}
\bar{2}.9756707 \\
1.7522898 \\
\hline
\end{array}$$

we have $.7279605 = \log.\ 5.345$; hence this term gives

$$\delta\theta = -5.345'' \sin(\lambda-\varpi_3) \ldots\ldots (A).$$

In like manner, equations a_1 and a_2 give respectively

$$\delta\theta = -.354'' \sin(\lambda-\varpi_4) \ldots\ldots (A_1)$$

$$\delta\theta = -.548'' \sin(\lambda+108.32) \ldots\ldots (A_2).$$

As the period of this inequality is very long, for very great exactness it would be necessary to take into account the variations of the elements of the orbits. The principal effect of this variation is to lengthen the period of the inequality, and this is equivalent to causing a small diminution of the divisor, which would somewhat increase the amount of the inequality; in fact, it appears to be increased by about a twenty-fourth of its whole amount.

But then, on the other hand, as the eccentricity of Mars is not very small, we ought also, for great accuracy, to take into account the higher powers of the eccentricities. The complete calculation of such terms would be very complicated; but it appears that by taking them into account the entire amount would be diminished by much about the same quantity by which it would be increased by taking into account the variations of the elements. Also the angles between the major axes of the planets are slowly varying; that between the axes of Mars and Jupiter, for instance, is slowly diminishing. The effect of this would be to cause a slight diminution in the value of such quantities as equation (*c*). But then, on the other hand, the eccentricities of both the orbits are on the increase, which would tend to increase the quantity; so that it will be seen that the change which it would undergo during one period or more of the long inequality, whether for greater or less, will be extremely small, and may be neglected. So that it would seem that if the work is correct, the first approximate value obtained as above will be a very exact one, quite as exact as is usually obtained, and will serve for one period or more, without sensible error; the error committed will certainly not amount to a second for Mars, or to more than a very small fraction of one for the Earth. It may also be not out of place to notice, that in determining the mass of Mars, from the comparison of the observed value of the perturbations caused by it with their theoretical value, since the latter are generally somewhat smaller when the higher powers of the eccentricities are taken into account, it follows that the mass of Mars, which would result from this comparison, when they are taken into account, will be most likely somewhat larger than if they were omitted.

The values of $\delta\theta$, above given, are those which result simply from the function $\int_t \int_t d_t(\mathrm{R})$, which is twice divided by the very small divisor .0010585, this being the value of the quantity $\frac{8n_3-3n_4-4n_2}{n_3}$. The terms which would arise from the other terms in the equation for the longitude, $2\int_t rd_r\mathrm{R}$, for instance, will be quite insensible.

Terms resulting from (*b*) and (b_1).

The argument of these is $3n_3t-3n_4t$; and hence the quantity λ will result from the combination of these with the angles,

Inequalities resulting

from equations (b) and (b_1).

$$4n_3t-4n_2t,\ n_3t;$$ and with $5n_3t-5n_2t$, n_2t.

let $n_2t+\varepsilon_\varepsilon=\phi_2$, etc. Then if in the terms belonging to R,

$R_4 \cos 4\,\overline{\theta-\theta'}$, and $R_5 \cos 5\,\overline{\theta-\theta'}$, we substitute for $r\ r'$ and $\theta\ \theta'$, their values

$$r_3=a\Big(1-e_3\cos(\phi_3-\varpi_3)-.951068''\cos(3\phi_3-3\phi_4)\Big)$$

$$r'=a'\,(1-e_2\cos\overline{\phi_2-\varpi_2})$$

$$\theta_3=\phi_3+2e_3\sin(\phi_3-\varpi_3)+1.19503''\sin(3\phi_3-3\phi_4)\Big)$$

$$\theta'=\phi'+2e_2\sin(\phi'-\varpi_2)$$

we shall obtain

$$\mathrm{R}=-m'(9\mathrm{A}_4+a'd_{a'}\mathrm{A}_4)\,1.19503''\,e_3\cos(\lambda-\varpi_3)$$

$$-m'\tfrac{1}{4}(10\mathrm{A}_4+12a'd_{a'}\mathrm{A}_4+a'^2d^2_{a'}\mathrm{A}_4).951068''\,e_3\cos(\lambda-\varpi_3)$$

$$+\frac{5}{4}m'(10\mathrm{A}_5+a'd_{a'}\mathrm{A}_5)1.19503''\,e_2\cos(\lambda-\varpi_2)$$
$$+\tfrac{1}{4}m'(10\mathrm{A}_5+12a'd_{a'}\mathrm{A}_5+a'^2d^2_{a'}\mathrm{A}_5).951068''\,e_2\cos(\lambda-\varpi_2)$$

$$=-.44269''\,\frac{m'}{a}\cos(\lambda-\varpi_3)+06342''\,\frac{m'}{a}\cos(\lambda-\varpi_2)$$
$$=-.48361''\,\frac{m'}{a}\cos(\lambda+33^\circ.\,37'),$$

we have now to form the function $\dfrac{3}{a^2n_3}\int_t\int_t d_t(\mathrm{R})$ with this value of R, just as was done above; and by doing so, we obtain the term

$$\delta\theta=-27.339''\sin(\lambda+33^\circ.\,37')\ldots\ldots(\mathrm{B}).$$

And by the same process the equations (b_1) give

$$\delta\theta=4.380''\sin(\lambda+115^\circ.\,21')\ldots\ldots(\mathrm{B}_1).$$

Inequality re-

Term depending upon (c) and (c_1).

The terms (c) and (c_1) it is easily seen will have to be multiplied by the squares of the eccentricities and inclinations: for simplicity we shall calculate these two parts separately. Then by making use of the terms (c) we find

sulting from equations (c) and (c_1).

$$R = -\frac{m'}{4}(104A_4 + 22a'd_{a'}A_4 + a'^2d^2_{a'}A_4)$$

$$\times 2.3180''\, e_3^2 \cos(\lambda - 2\varpi_2 + 50°.\, 6')$$

$$+ \frac{m'}{8}(550A_5 + 110a'd_{a'}A_5 + 5a'^2d_{a'}A_5)$$

$$\times 2.3180''\, e_3e_2 \cos(\lambda - \varpi_3 - \varpi_2 + 50°.\, 6')$$

$$- \frac{m'}{8}(342A_6 + 66a'd_{a'}A_6 + 3a'^2d^2_{a'}A_6)$$

$$\times 2.3180''\, e_2^2 \cos(\lambda - 2\varpi_2 + 50°.\, 6')$$

$$- \frac{m'}{16}(126A_4 + 174Aa'd_{a'}A_4 + 27a'^2d^2_{a'}A + a'^3d^3_{a'}A_4)$$

$$\times 1.4776''\, e_3^2 \cos(\lambda - 2\varpi_3 + 52°.\, 43')$$

$$+ \frac{m'}{8}(120A_5 + 166a'd_{a'}A_5 + 26a'^2d^2_{a'}A_5 + a'^3d^3_{a'}A_5)$$

$$1.4776''\, e_2e_3 \cos(\lambda - \varpi_2 - \varpi_3 + 52°.\, 43')$$

$$- \frac{m'}{16}(114A_6 + 158a'd_{a'}A_6 + 25a'^2d^2_{a'}A_6 + a'^3d^3_{a'}A_6)$$

$$1.4776''\, e_2^2 \cos(\lambda - 2\varpi_2 + 52°.\, 43')$$

which terms, reduced to numbers and put into combination, give $R = -\frac{m}{a}.36754'' \cos(\lambda + 118°.\, 41)$, which, integrated, etc., gives

$$\delta\theta = -20.7774'' \sin(\lambda + 118°.\, 41').$$

The part arising from the inclination of the orbit of Mars to the ecliptic appears to amount to only $-.0962'' \sin(\lambda - 45°)$, which, united with the former, gives

$$\delta\theta = -20.583'' \sin(\lambda + 118°.\, 37') \;.\,.\,.\,.\,.\; (C)$$

Inequality resulting from equation (*d*).

and by the same process the terms (c_1) give

$$\delta\theta = -1.490'' \sin(\lambda + 88°.7') \ldots\ldots (C_1).$$

It will be seen that in the part of R introduced by the term in the radius vector, the coefficients of the quantities A_4, A_5, A_6, decrease in arithmetical progression, as also do those of $a'd_{a'}A_4$, etc.

Calculation of the term depending upon (*d*). This term is multiplied by the cubes of the eccentricities. Hitherto the terms have been obtained by the actual substitution of the true coördinates of Mars in R; and we might calculate the following term by the same method, but another way is preferable. For, since the elliptic values of the expansion of R have been already calculated, and tables of them formed (See Pontécoulant, *Systéme du Monde*, vol. iii.) it will save trouble, in cases where higher powers of the eccentricities have to be employed, if we can deduce the complete value of R from its elliptic value, just as this is itself deduced from the value which it would have, supposing the eccentricities were 0.

Let then R′ be the elliptic value of R; then if R be the complete value, it is evident that R is what R′ becomes when r and θ become $r+\delta r$, $\theta+\delta\theta$; therefore, by the differential calculus, $R = R' + d_\theta R'\delta\theta + d_r R'\delta r$; the only parts of which will be wanted are the two latter. The calculation of the first of them is very simple, for if in general $R' = R'_0 + \ldots\ldots + R'_k \cos\overline{\theta-\theta'}$, we shall have $d_\theta R = -kR_k \sin k\overline{\theta-\theta'}$, that is, it will be the same as the corresponding term of R′, but multiplied by $-k$, and with sin instead of cos. Now the term $R'_4 \cos\overline{4\theta-\theta'}$ will contain the term

$$-\frac{m}{48}(1471A_4 + 447a'd_{a'}A_4 + 39a'^2d^2_{a'}A_4 + a'^3d^3_{a'}A_4)$$

$$\times e_3^3 \cos(7\phi_3 - 4\phi_2 - 3\varpi_3)$$

$$= P\cos(7\phi_3 - 4\phi_2 - 3\varpi_3), \text{ suppose;}$$

then we shall have by what has gone before,

$$d_\theta R' = -4\,P\sin(7\phi_3 - 4\phi_2 - 3\varpi_3);$$

let this now be multiplied by $\delta\theta$, or by its value $3.3273'' \sin(\phi_3 - 3\phi_4 - 1^\circ.14)$, and we shall have, on restoring the value of P, $d_\theta R'\delta\theta$

$$= -\frac{m'}{24}(1471A_4 + 447a'd_{a'}A_4 + 39a'^2d^2_{a'}A_4 + a'^3d^3_{a'}A_4)$$

$$\times 3.3273'' e_3^3 \cos(\lambda - 3\varpi_3 - 1^\circ.14).$$

and in like manner we shall have for the remaining terms

$$+m'\frac{5}{32}(1490\,A_5 + 435a'd_{a'}A_5 + 38\,a'^2d^2_{a'}A_5 + a'^3d^3_{a'}A_5)$$

$$\times 3.3273'' e_3^2\,e_2 \cos(\lambda - 2\varpi_3 - \varpi_2 - 1^\circ.14)$$

$$-m'\frac{3}{16}(1482\,A_6 + 422\,a'd_{a'}A_6 + 37\,a'^2d^2_{a'}A_6 + a'^3d^3_{a'}A_6)$$

$$\times 3.3273'' e_3\,e_2 \cos(\lambda - \varpi_3 - 2\varpi_2 - 1^\circ.14')$$

$$+m'\frac{7}{96}(1456\,A_7 + 408a'd_{a'}A_7 + 36a'^2d^2_{a'}A_7 + a'^3d^3_{a'}A_7)$$

$$\times 3.3273'' e_2^3 \cos(\lambda - 3\varpi_2 - 1^\circ.14'),$$

which terms, reduced to numbers and put into combination and integrated, etc., give the term

$$\delta\theta = -4.874'' \sin(\lambda + 99^\circ.37').$$

The finding of the term $d_rR'\delta r$ is somewhat more complicated; it is done thus: $d_rR' = d_aR'd_ra$, or if $r = a\overline{1+v}$ $d_ar = 1 + v = \frac{r}{a}$ $\therefore d_rR' = d_aR'\frac{a}{r}$. (M. Pont., vol. iii., p. 20).

$$\text{Also, } \frac{a}{r} = 1 + e\cos\overline{\phi - \varpi} + e^2\cos\overline{2\phi - 2\varpi}$$

$$+\frac{9}{8}e^3\cos 3\overline{\phi - 3\varpi}.$$

Hence we must find all terms in R′, which, when multiplied by this, will give terms of the form $\cos(7\phi_3 - 4\phi_2)$, since this is the quantity which by combination with the terms in equations (*d*), will produce a term of the required form; and first for those terms which contain only the eccentricity of Mars.

These will be,

$$\mathrm{R}' = -m'\,\mathrm{A}_4 \cos \overline{4\phi_3 - 4\phi_2}$$

$$-\frac{m'}{2}(9\mathrm{A}_4 + a'd'_a\mathrm{A}_4)\, e_3 \cos(5\phi_3 - 4\phi_2 - \varpi_3)$$

$$-\frac{m'}{8}(104\mathrm{A}_4 + 22a'd_{a'}\mathrm{A}_4 + a'^2 d^2_{a'}\mathrm{A}_4)\, e_3^2 \cos(6\phi_3 - 4\phi_2 - 2\varpi_3)$$

$$-\frac{m'}{48}(1471\mathrm{A}_4 + 447a'd_{a'}\mathrm{A}_4 + 39a'^2 d^2_{a'}\mathrm{A}_4 + a'^3 d^3_{a'}\mathrm{A}_4)$$

$$\times e_3^3 \cos(7\phi_3 - 4\phi_2 - 3\varpi_3)$$

also, $d_a\mathrm{R}' = -\frac{\mathrm{R}'}{a} - \frac{1}{a}a'd_{a'}\mathrm{R}$; and by differentiating the above value of R, we have

$$-\frac{1}{a}a'd_{a'}\mathrm{R} = \frac{m'}{a}a'd'_a\mathrm{A}_4 \cos(4\phi_3 - 4\phi_2)$$

$$+\frac{m'}{2a}(10a'd_{a'}\mathrm{A}_4 + a'^2 d^2_{a'}\mathrm{A}_4)\, e_3 \cos(5\phi_3 - 4\phi_2 - \varpi_3)$$

$$+\frac{m'}{8a}(126a'd_{a'}\mathrm{A}_4 + 24a'^2 d^2_{a'}\mathrm{A}_4 + a'^3 d^3_{a'}\mathrm{A}_4)$$

$$\times e_3^2 \cos(6\phi_3 - 4\phi_2 - 2\varpi_3)$$

$$+\frac{m}{48a}(1918a'd_{a'}\mathrm{A}_4 + 525a'^2 d_{a'}\mathrm{A}_4 + 42a'^3 d^3_{a'}\mathrm{A}_4 + a'^4 d^4_{a'}\mathrm{A}_4)$$

$$\times e^3 \cos(7\phi_3 - 4\phi_2 - 3\varpi_3).$$

Therefore, by taking the sum of $\mathrm{R}' + a'd_{a'}\mathrm{R}$, we have

$$d_a\mathrm{R}' = \frac{m'}{a}(\mathrm{A}_4 + a'd_{a'}\mathrm{A}_4) \cos(4\phi_3 - 4\phi_2)$$

$$+\frac{m'}{2a}(9\mathrm{A}_4+11a'd_{a'}\mathrm{A}_4+a'^2d^2_{a'}\mathrm{A}_4)\,e_3\cos(5\phi_3-4\phi_2-\varpi_3)$$

$$+\frac{m'}{8a}(104\mathrm{A}_4+148a'd_{a'}\mathrm{A}_4+25a'^2d^2_{a'}\mathrm{A}_4+a'^3d^3_{a'}\mathrm{A}_4)$$

$$\times e_3^2\cos(6\phi_3-4\phi_2-2\varpi_3)$$

$$+\frac{m'}{48a}(1471\mathrm{A}_4+2365a'd_{a'}\mathrm{A}_4+564a'^2d^2_{a'}\mathrm{A}+43a'^3d^3_{a'}\mathrm{A}_4$$

$$\times a'^4d^4_{a'}\mathrm{A}_4)\,e_3^3\cos(7\phi_3-4\phi_2-3\varpi^3)\,;$$

therefore, multiplying this by $\frac{a\delta r}{r}$, or by its value

$$-(1+e_3\cos\overline{\phi_3-\varpi_3}+e_3^2\cos\overline{2\phi_3-2\varpi^3}+\frac{9}{8}e_3^3\cos\overline{3\phi_3-3\varpi_3})$$

$$\times a\,.864''\cos(\phi_3-3\phi_4-6^\circ.\,18')\,;$$

we have for the part of R depending on the powers of the eccentricity of Mars only,

$$d_r\mathrm{R}'\delta r=-\frac{m'}{96}.864''(1918\mathrm{A}_4+2968a'd_{a'}\mathrm{A}_4+651a'^2d'^2_a\mathrm{A}_4$$

$$+46a'^3d^3_{a'}\mathrm{A}_4+a'^4d^4_{a'}\mathrm{A}_4)\,e_3^3\cos(\lambda-3\varpi_3-6^\circ.\,18')$$

and, in like manner, the remaining terms of R depending upon e_3^2, e_2, etc., are

$$+\frac{m'}{32}.864''(1750\mathrm{A}_5+2716a'd_{a'}\mathrm{A}_5+603a'^2d^2_{a'}\mathrm{A}_5$$

$$+44a'^3d^3_{a'}\mathrm{A}_5+a'^4d^4_{a'}\mathrm{A}_5)\,e_3^2\,e_2\cos(\lambda-2\varpi_3-\varpi_2-6^\circ.\,18'$$

$$-\frac{m'}{32}.864''(1596\mathrm{A}_6+2484a'd_{a'}\mathrm{A}_6+558a'^2d^2_{a'}\mathrm{A}_6$$

$$+42a'^3d^3_{a'}\mathrm{A}_6+a'^4d^4_{a'}\mathrm{A}_6)\,e_3\,e_2^2\cos(\lambda-\varpi_3-2\varpi_2-6^\circ.\,18')$$

$$+\frac{m'}{96}.864''(1456\mathrm{A}_7+2272a'd_{a'}\mathrm{A}_7+516a'^2d^2_{a'}\mathrm{A}_7$$

$$+40a'^3 d^3_{a'} A_7 + a'^4 d^4_{a'} A_7)\, e_2^3 \cos(\lambda - 3\varpi_2 - 6^\circ.\, 18'),$$

which being reduced to numbers and put into combination and integrated, etc., give

$$\delta\theta = -2.228 \sin(\lambda + 91^\circ.\, 56'),$$

which united with the part previously found, gives

$$\delta\theta = -7.101'' \sin(\lambda + 97^\circ.\, 10') \ldots\ldots (\text{D.})$$

It will here be seen that the coëfficients of the quantities A_4, A_5, etc., are not in arithmetical progression, as they were in a former case; but here the *first differences* of the coëfficients are in arithmetical progression, as are also those of $a'd_{a'}A_4$, $a'd_{a'}A_5$, etc., these differences being respectively, 168, 154, 140; 252, 232, 212; 48, 45, 42. The remaining ones are in arithmetical progression. This may serve as a sort of test of their correctness. This method was also used to verify the results, equations (c). The part depending upon the inclination of the orbits is of no importance. The term depending upon (e) will be omitted for the present.

Inequalities resulting from equations(f) and (g).

The remaining terms, *i. e.* those depending upon (f) and (g), belong to the coördinates of the Earth; and therefore we must remember that in the differentiation of R, $8n_3t$ is the only part which belongs to the coördinates of Mars; also, the terms in the expansion of R, which will be required, are,

$$R_6 \cos 6\,\overline{\theta - \theta'} \quad R_7 \cos 7\,\overline{\theta - \theta'}. \quad R_8 \cos 8\,\overline{\theta - \theta'}.$$

The term arising from (f) appears to be

$$\delta\theta = 2.194'' \sin(\lambda + 33^\circ.\, 16') \ldots\ldots (\text{F}),$$

and that from (g) is

$$\delta\theta = 4.749'' \sin(\lambda + 78^\circ.\, 2') \ldots\ldots (\text{G.})$$

Combination of these inequalities.

The terms above found appear to be the only ones of any importance in the direct mutual perturbation of Mars and the Earth; collecting them and putting them into combination, we have for the inequality of Mars, produced by the direct action of the Earth,

$$\delta\theta_3 = -44.442'' \sin(\lambda + 75^\circ.\,14').$$

The corresponding quantity for the Earth will be found very approximately by multiplying this by $-\frac{m_3}{m_2}\sqrt{\frac{a_3}{a_2}}$; the logarithm of this latter quantity is

$\bar{1}.2151410$, that of $44.442''$ is 1.6477936; therefore we

obtain by addition

$$\begin{array}{r} \bar{1}.2151410 \\ 1.6477936 \\ \hline .8629346 = \log.\ 7.293''; \end{array}$$

hence for the Earth

Total result for the Earth.

$$\delta\theta_2 = 7.293'' \sin(\lambda + 75^\circ.\,14'). \quad (1.)$$

It only remains to consider the effect of the terms in equations (*e*). We are now engaged with the direct action of Jupiter upon Mars, and therefore must remember that the quantity $8\phi_3 - 4\phi_2$ now belongs to the coördinates of Mars. The term resulting from (*e*) appears to be

$$\delta\theta_3 = -1.815'' \sin(\lambda - \varpi_3) \ldots\ldots (\mathrm{E})$$

which, united with the value of $\delta\theta_3$, above found, gives for the entire perturbation in the longitude of Mars,

Total result for Mars.

$$\delta\theta_3 = -45.684'' \sin(\lambda + 73^\circ.34'). \quad (2.)$$

There will also be a term of the same form in the longitude of Jupiter, but it will be perfectly insensible.

Also, the term in $r\delta r$ corresponding to this, will produce, by substitution in the function $\frac{3}{2} er\delta r \cos \overline{\phi_3 - \varpi_3}$, etc., the terms in the longitude of Mars

$$\delta\theta_3 = -4.262'' \sin(7\phi_3 - 4\phi_2 - 3\phi_3 + 45^\circ.\,57'). \quad (3.)$$

$$+4.262'' \sin(9\phi_3 - 4\phi_2 - 3\phi_3 + 101^\circ.\,11'). \quad (4.)$$

To the former of these will have to be added a few small terms, arising from the substitution of the quantities (*a*), (*b*), etc., in the differential equations; but they are so minute that they may be neglected. Also, corresponding to these two latter equations, there will be the term in the radius vector

$$\delta r_3 = 213'' \cos(7\phi_3 - 4\phi_2 - 3\phi_3 + 45°.\,57')$$

$$-2.13'' \cos(7\phi_3 - 4\phi_2 - 3\phi_3 + 101°.\,11')$$

Amount of the Earth's displacement at the present time.

It must be mentioned that t is supposed here to commence with the year 1800.

It may be worth while to see how the present position of the Earth is affected by the above inequality. This will be done by substituting for n_3, e_3, etc., their numerical values. The values of e_3, etc., for the year 1800 are $\varepsilon_3 = 230°.49'.50''$, $\varepsilon_2 = 100.23.32$, $\varepsilon_4 = 81.52.10$, then $8\varepsilon_3 = 1862°.\ 38'.\ 40''$, $4\varepsilon_2 = 401.38.8$, $3\varepsilon_4 = 245.32.30$, by means of these values and those of n_3, etc., previously given

$$\delta\theta_2 = 7.293'' \sin(729.39t + 210°.\,46'),$$

$$\text{or} - 7.293'' \sin(729.39t + 30°.\,46'),$$

from which we see that the Earth is at present behind its mean place; and by making $t=57$, we shall find that for the beginning of this year $\delta\theta = -7.293'' \sin 43°.\ 58' = -5.06''$, which gives the quantity by which it is in arrear of its mean place.

The time when it was at its mean place will be found by making $729.39''t + 30°.\ 46' = 0$, which will give $t = -151.8$, that is, it was at its mean place about 151.8 years before the year 1800, or about 209 years ago; since which time it would appear to have fallen back about 5″, and it will attain its greatest negative value in about 240 years after this, and the motion will then begin to be accelerated.

As the period of this inequality is very long, and its amount small, it will take a long course of the most careful observations to determine the circumstances of it, or even to detect its existence at all: nevertheless, if it is correct, it may ultimately be done with quite as much certainty and accuracy as any other inequality of the same amount in which the period was shorter. Of the three bodies which are principally affected by it, that in which it will probably be by far the most considerable, is the Moon; and, consequently, it would seem that this is the body in

Small inequality in the motion of the Earth.

which it will be most easily detected by observation. Before going to the calculation of any other inequalities which exist, it may be well to make a few remarks upon the one which has been just examined. It is remarkable not only for the facts that have been mentioned, such as its effects upon the motion of the Moon, etc., but for the extreme smallness of the quantities which produce it. Mars is one of the smallest of the planets, and the inequalities in its motion, which give rise to it, are very minute. There appears to be a small inequality of long period in the motion of the Earth produced by the long inequality of Jupiter and Saturn, which, though it does not appear to amount to more than about the third of a second, as its period is about 900 years, may have a sensible effect on the motion of the Moon. It is needless to give the calculation at length; but the following terms, taken from M. Pontécoulant, are the principal ones which produce it. In the coördinates of Jupiter, we have

$$\delta\theta = -1187'' \sin(5\phi_5 - 2\phi_4 + 3^\circ\ 40')$$

$$-161'' \sin(5\phi_5 - 3\phi_4 - 58^\circ.\ 11')$$

$$\delta r = -.000292 \cos(5\phi_5 - 2\phi_4 - 15^\circ.33')$$

$$-.00202 \cos(5\phi_5 - 3\phi_4 - 58^\circ.\ 7');$$

and in those of Saturn,

$$\delta\theta = -2906'' \sin(5\phi_5 - 2\phi_4 + 3^\circ.\ 38')$$

$$+652.59'' \sin(4\phi_5 - 2\phi_4 - 59^\circ.34')$$

$$\delta r = -.00095 \cos(5\phi^5 - 2\phi_4 + 32^\circ.32')$$

$$+01479 \cos(4\phi_5 - 2\phi_4 - 59^\circ.\ 28').$$

The values of δr here given are expressed in parts of the radius of the Earth's orbit.

All these quantities together appear to produce the inequality in the orbit of the Earth

$$\delta\theta = -.354'' \sin(5\phi_5 - 2\phi_4 - 34^\circ.50'). \quad (5.)$$

There are many other combinations of terms like these, which produce small divisors, but no others that I have found in the case of the Earth, which seem to be of importance. As, for instance, the terms depending upon

$$3\phi_1-7\phi_2+4\phi_3, \text{ and upon } 5\phi_1-6\phi_2-4\phi_3.$$

These, as well as others which there are, may perhaps produce an inequality of a few seconds in the Moon's motion, and so, perhaps, may be worth examination; otherwise they are of no importance. The former appears to amount to about one-fourth of a second; the latter is still less.

The principal steps in the calculation of the terms depending on $2\phi_4-6\phi_5+3\phi_6$, mentioned above, and upon $\phi_5-4\phi_6+2\phi_7$, as well as one or two involving the coördinates of four planets, will be given in a future number.

ART. II.—*On the Physical Structure of the Earth.* By HENRY HENNESSY.

The figure of the Earth proves it to have been once in a state of fluidity.

THAT our planet was once in a condition of complete fluidity, is clearly indicated by what Alexander von Humboldt has so happily called the greatest of all geognostical phenomena, the flattening of the earth towards its poles, and its outswelling towards the equator. While the labours of mathematical investigators, since the time of Newton, have rendered more evident the explanation of this phenomenon by the fundamental principles of mechanics, the estimate of its absolute amount has been found more and more coincident with the results of observation. Playfair and Sir John Herschel have, it is true, pointed out the possibility of the earth acquiring a spheroidal shape from the abrading action of its liquid coating; but neither of these philosophers have followed out all the consequences flowing from the mechanical conditions of the problem they had stated. The prominent position given to their views, in connexion with certain geological theories, and especially by one of the ablest writers of the present day,[1] induced me some years ago to give some attention to the question.[2] By the aid of deve-

Imperfect attempts to explain the Earth's figure without the hypothesis of fluidity.

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[1] See Lyell's Principles of Geology, chap. 18, seventh ed.; chap. 31, ninth ed.

[2] Proceedings of the Royal Irish Academy, vol. iv., p. 333.

lopments in series of Laplace's coefficients, I obtained a mathematical expression for the equilibrium of the watery coating of the abraded spheroid. This expression contains terms depending on the density of land and water, and on the mean density of the earth. Among other results deduced from it, it appears that on the abrasion theory, the difference between the equatorial and polar axes of the fluid covering of the earth, could not exceed $\frac{1}{404.6}$ of its mean radius. Observation shows that its true value is about $\frac{1}{300}$, and thus we are compelled to regard the abrasion theory of the earth's figure as inadequate to satisfy all the requirements of a perfect theory.

The former fluid state of the Earth resulting from intense heat.

In proceeding to consider the general structure of the earth, it may thus be fairly assumed that it was at one time in a fluid state, in other words, that it was in a state of fusion from intense heat. It is difficult to conceive any other means of satisfying the condition of fluidity; and direct observations, in every instance that they have been made, clearly prove the existence of a temperature, at points not far below the surface of our planet, which would suffice to melt nearly every substance coming under our notice.

Process of solidification of the Earth.

If the physical properties of the substances existing in the earth's interior do not essentially differ from those which come under our observation, it is possible to arrive at an approximate knowledge of the internal structure of our planet by studying the physical and mechanical changes which would take place during the solidification of substances in a fused state. The fused matter composing the earth would at first evidently consist of a series of spheroidal layers of equal pressure and density, arranged symmetrically around their common centre, the density of each layer increasing with the pressure from the surface to the centre. If pressure were very effective in solidifying the matter of the earth, it might be possible that solidification would commence at the centre. But as yet we have no reason to conclude that great pressure and great density of fused matter may not be inconsistent with its state of fluidity. This is rendered still more manifest by certain conclusions deduced from the dynamical theory of heat, which I have communicated to the British Association.[3] The experiments of M. Cagniard de Latour show that certain gases and vapours may acquire the density of liquids, while still retaining their aeriform condition, provided that the temperature continues extremely high. But, even allowing the possibility of the formation of a solid nucleus from the influence of pressure at the centre of the Earth, where the pressure on the fluid would be greatest, it will soon appear that this nucleus could not long exist under the conditions accompanying the solidification of the superficial parts of the fluid. If we define the solid crust of the Earth as that portion of it which would be laid bare by stripping off all the rocks evidently deposited as sedimentary formations, experiment proves that when the rocks composing the crust of the Earth, as thus defined, are reduced by heat to a fluid condition, and then allowed to solidify, they contract in volume to a very considerable extent. The density of the solidifying portions will be thus considerably increased, and the first effect of refrigeration on the superficial stratum of the fused mass will therefore be, to cause portions of that stratum to sink downwards through the next adjoining stratum, until they arrive at another of equal density with themselves. The extremely small conducting power of such fused matter will permit us to entirely neglect the direct influence of conduction between such portions of the fluid as are not in close contact; consequently the cooling of the remaining strata will take place chiefly by the influence of the descending solidified portions. The portions of the fluid so cooled by contact would also tend to change their positions and to descend in a similar manner. A process of convection would thus take place at the surface of the fluid, but the following causes would tend to impede its propagation towards the interior of the mass:—

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[3] See Athenæum, September 5, 1857, p. 1120.

Definition of the solid crust of the Earth in the present inquiry.

1. The fluid rendered dense by refrigeration would descend into strata successively denser from compression.
2. The passage of the cooled matter through these strata would tend to make them still more dense.
3. The densities of the portions descending from the surface, would be diminished by the increase of their own temperature from contact with strata nearer to the centre.

From these actions, not only would the cooled portions of the superficial strata of the fluid come more quickly in contact with strata of the same density, below which they could not further descend, but also, their motions would be more resisted in proportion to the density of the strata passed through; and thus the energy of the process of convection, unlike the same process in a perfectly homogeneous

Why solidification should commence at the surface so as

to form the crust of the Earth.

and limpid fluid, such as we see it exhibited in the familiar phenomenon of water boiling, would rapidly diminish from the surface of the spheroid towards its centre. The principal oscillations of the fluid, owing to convection, would therefore take place near the surface. The viscidity of the igneous fluid, just before entering the solid state, would interpose so great an obstacle to the descent of the solid masses formed on its surface, as to allow them to remain floating sufficiently long to become aggregated into more or less continuous sheets, enveloping the fluid matter below. The manner in which stones are supported when thrown on the viscous surface of the fused matter flowing from the crater or sides of a volcano during an eruption, has been long since remarked by Spallanzani[4] and other observers. And it is from this peculiarity of the lava that the portion still fluid is capable of supporting even detached masses that have become solid on its surface. Thus, when these masses become united in a continuous sheet, a stream of still fluid lava is found arched over with a solid, continuous flooring, on which observers can safely tread.

A solid crust might thus be formed at the earth's surface, long before the process of convection extended to any great depths. We should thus ultimately have a solid shell containing within it a mass of matter still in a fused condition. That this is the most probable nature of the process which would take place, appears from other phenomena accompanying the cooling of igneous rocks. The formation of volcanic bombs presents us in miniature with something analagous to the process of solidification that occurs on a grand scale within the crust of the globe. I shall have occasion to refer to a very instructive instance of this kind, which came under the notice of Mr. Darwin, and which I have already quoted elsewhere.[5]

After the formation of the first stratum of the shell, it is probable that its extreme tenuity (compared to the Earth's radius) would subject it to continual rupture and displacements, from the forces acting upon it; but, in studying the manner in which the solidification of the mass proceeds, we shall, for the present, abstract such disturbing causes. The passage of any fluid stratum in contact with the solid shell, from its fluid condition to the solid state, would be accompanied by the elimination of latent heat. A portion of this heat passing downwards to the strata reduced in temperature by convection, would tend to further neutralize the effects of that process, and to render the cooling of the whole mass more gradual.

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[4] Voyage dans les Deux Siciles, t. i., p. 62

[5] Phil. Mag., August, 1856.

Changes in the distribution of matter within the Earth produced by the process of solidification.

If we conceive the stratum of fluid in contact with the shell, and which is on the point of passing to the solid state, to be divided into an infinite number of prisms, each having its axis pointed in the direction of a radius from the centre of the Earth, it will suffice to examine what happens to one of these prisms, in order to understand the process of solidification of the entire stratum. When the temperature of the prism has been sufficiently reduced to cause it to become solid, it will contract in volume perpendicularly to the surface of the shell, and thus tend to leave an empty space between itself and the remaining fluid, in the direction of the line joining it with the centre of the Earth. This canal of fluid will, therefore, be free from the pressure of its solidified outer stratum; and if the density of its several strata be due to the pressure they support, it follows that they will thus tend to expand outwards, so as to fill up the empty space left by the contraction of the outer stratum. This tendency to expansion will, however, be in some measure counteracted by the slow contraction of the entire fluid, from the gradual loss of its heat. The density of each stratum of the fluid, in going from its surface to its centre, will evidently vary with less rapidity than before any of it had solidified; the pressure, and consequently the density, at its centre, will constantly diminish with each successive addition to the inner surface of the shell. If a solid nucleus had been originally formed at the centre from the effect of pressure, the conditions accompanying its solidification would thus be diminishing in energy; for it is evident that but little change could take place in the temperature at that point, compared to other portions of the mass. It appears, therefore, that the transition of the fluid matter to the state of solidity at the inner surface of the shell, would take place in such a way as to cause a transport of matter from the interior of the Earth towards its surface, and such as, at the same time, to render the fluid matter enclosed within the shell more homogeneous, the more advanced the process of solidification.

Illustration from the

The observations of Mr. Darwin on one of the volcanic bombs which he had found in the Island of Ascension, afford an

Appearances presented by volcanic bombs.

interesting illustration of the foregoing remarks. He noticed several such bombs, of which he selected one as the best characteristic type of their interior structure. He exhibits a figure and description of the specimen in his *Naturalist's Voyage*, p. 493. When broken, the specimen showed that its central part was coarsely cellular, the cells decreasing in size towards the outer portion; this cellular mass was surrounded by a hard, shell-like casing, about one-third of an inch in thickness; this was again covered over with a coating of finely cellular lava. He accounts for these appearances by saying that the external crust must have cooled rapidly into the state in which it was actually observed; then the lava still fluid within was urged by the centrifugal force developed by the rotation of the bomb, as it spun around its centre while moving through the air, and thus was produced the compact, strong shell; and lastly, the centrifugal force, by relieving the pressure on the central parts of the mass, allowed the vapours there to expand their cells, thus producing the coarsely cellular structure of the interior. In this case, the energetic action of the centrifugal force caused the phenomena to be developed in a very striking manner; but it is manifest that any other force tending to expand the fluid enclosed by the external solid shell, would have more or less of the same tendency generally, namely, the removal of matter from the interior to the exterior of the cooling mass. The expansive tendency of the fluid composing the nucleus of the Earth, if greater than its contraction from the slow refrigeration of its entire mass, would also develop a series of pressures at the inner surface of the shell. The existence of such pressures seems, moreover, to be indicated by another circumstance connected with the Earth's structure, which we shall presently examine.

In my *Researches in Terrestrial Physics*,[6] I have shown that the tendency of the matter composing the nucleus to become successively more homogeneous, would modify the form of the surface of the nucleus. It would become more oblate with each successive diminution of its radius. The strata of the shell solidified from it, would therefore tend to become more oblate, and at a given period of the process of solidification of the Earth, the inner surface of the shell should possess an ellipticity greater, or at least not less, than that of its outer surface.

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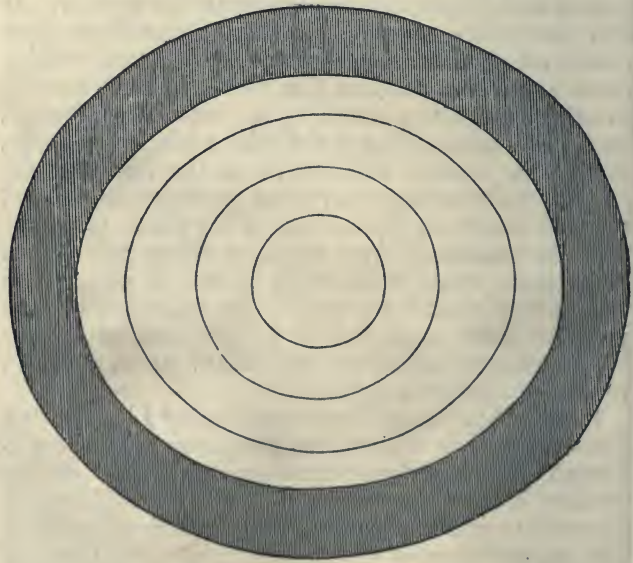
[6] Philosophical Transactions, 1851, Part II.

General arrangement of the strata of the solid crust of the Earth and of the fluid nucleus contained within it.

The oblateness of the strata of equal density of the nucleus would still follow the general law of diminution, in going from the surface of the nucleus to its centre, though the rapidity of that diminution would not remain always the same, under the conditions of decreasing dimensions and decreasing density of the fluid mass. The appearance finally presented by a section made through the Earth's centre, would be somewhat like that indicated in the adjoining figure. The shaded portion represents the solid shell, and the ellipses drawn within the light portion represent the forms of the strata of equal density in the fluid nucleus.

The ellipticities of the inner and outer surfaces of the shell, are here represented as equal, while those of the surfaces of equal density in the nucleus, are represented as diminishing towards the centre.



Erroneous assumption with

Hitherto, the exterior figure of the Earth, and the arrangement of its internal strata of equal density, have been treated by mathematical investigators on the hypothesis that the particles of the fluid underwent no change whatever in their positions on entering into the solid state. This formed the basis of the investigations of Clairault and Laplace, and seems even to have been tacitly assumed by Mr. Hopkins, in his valuable inquiries as to the influence of the Earth's internal structure on the phenomena of precession and nutation. I had, in the first part of my *Researches*, pointed out the necessity of discarding so useless and embarrassing a supposition, and in the second part was enabled to apply certain experimental results, which appear to show that the assumption is altogether inadmissible.

which the hypothesis of the primitive fluidity of the Earth had been encumbered.

Important results regarding the internal structure of the Earth follow from discarding this erroneous assumption.

On this erroneous supposition, the forms of the strata of the solidified shell would, of course, correspond strictly with the figures of the strata of equal density in the original fluid mass, before any of it had passed to the solid state. The importance of discarding this superfluous error, and of considering the fluid matter originally or actually composing a great part of the Earth as possessing similar physical properties to fused rocks, coming under our notice, becomes immediately apparent by the remarkable difference in the results as to the internal structure of the globe. This conclusion will be rendered still more apparent by comparing my results with one of the most important of those to which Mr. Hopkins has been led. He has shown that, if P_1 denotes the precessional motion of the Earth, considered as a solid, homogeneous spheroid, with the ellipticity ε_1, and P', the precession of the Earth, considered as a heterogeneous fluid nucleus enclosed in a heterogeneous solid spheroidal shell, of which the interior and exterior ellipticities are respectively ε and ε_1, we shall have the relation:—

$$P' - P_1 = \left(1 - \frac{\varepsilon}{\varepsilon_1}\right) F\ (a)\ P_1$$

$F\ (a)$ being a function of a, the radius of the nucleus, and always a little less than unity. From what has been stated, it appears that ε cannot exceed ε_1, consequently P' cannot exceed P_1, a result totally different from that obtained by observation. I should add that Mr. Hopkins's result is founded upon the supposition that the transition from the perfect fluidity of the mass to the complete solidity of the shell, is not gradual but abrupt, and that no viscidity, molecular pressure, or friction exists at their surfaces of contact. It is evident that all these assump-

Pressure

and friction exist between the fluid nucleus of the Earth and its solid envelope.

tions must be abandoned; and, on the contrary, I have been led to conclude that, between the shell and nucleus, pressure and friction actually exist to so great a degree as to cause the entire mass to rotate in space very nearly as one solid body.

To more clearly understand how a normal pressure may exist at the surface of contact of the nucleus and shell, let us consider what would take place if the shell solidified without any contraction taking place in the particles of the fluid on changing their condition. The density of the strata of the shell would, as already stated, be the same as that of the fluid strata which they replaced. The density of the surface stratum of the nucleus having the radius a, would be the same as that which it possessed when it was merely an internal stratum of equal pressure; it would, therefore, depend on the pressure; for if the density of any stratum of the fluid is proportional to the pressures of the outlying strata, that density must be a function of the depth below the surface. The pressure of the fluid against every unit of surface of the shell will therefore be represented by the area of that unit of surface, multiplied by the height of a column of fluid required to compress the surface of the original fluid to the density of the stratum, situated at the distance a from the centre. In this case, therefore, such a pressure, so far from being negligible, would be so enormous as apparently to render unnecessary any further inquiry as to the movements of the fluid and solid portions of the Earth. Investigators of the figure and structure of the Earth, such as Laplace, who have neglected to consider the change of physical properties of the fluid matter on entering the solid state, seem to have been conscious of the result of their omission by treating the dynamical problems of the Earth's rotation as if the nucleus and shell moved together as one solid mass. Contraction of the matter of the Earth's nucleus on its congellation from the fluid state, would diminish the pressure against the shell. If we adopt for illustration the most reasonable law of the pressure Π, and density ρ, at any stratum of the fluid

$$\frac{d\Pi}{d\rho}=2c\rho\,;$$

then, in the case where there is no contraction, we shall have at a unit of surface of the shell $\Pi'=c\rho_1^2+C$. When

Influence of change of state of the fluid on the pressure exercised by it against the Earth's crust.

contraction is introduced, it will follow, as I have shown,[7] that the coefficient of contraction will continually approach to unity, in going from the surface of the Earth to its centre, during the stages of its solidification, where it will finally attain that value.

In the case of contraction, we may write for the same radius of the surface of the nucleus, $\Pi' = c\rho'^2 + C'$, in which $\rho' = K\rho_1$, K being a function of the coefficient of contraction k, of the fluid having the density ρ' when it passes to the fluid state. As $\rho' = k\rho_2$, ρ_2 being the density of the stratum of solid shell formed by its solidification; and as ρ_2 is generally greater than ρ_1, it follows that K must be greater than k, for

$$k\rho_2 = K\rho_1, \text{ or } K = k\frac{\rho_2}{\rho_1} \text{ and } \rho_1 \angle \rho_2, \text{ etc.}$$

The almost entire absence of conducting power in the fluid, and the impediments already adduced to show that rapid convection could not extend to any considerable distance below its surface, seem to show that the slow contraction of any column of fluid, reaching from its centre to its surface, will be much less than what would be at first supposed. There are, therefore, reasonable grounds, independently of the result deduced from Mr. Hopkins's researches, that the difference between the expansive tendency of the nucleus and its general contraction would result in a pressure at the inner surface of the shell. It is only sufficient to remember that the slow accession of matter from the nucleus to the shell, during the process of terrestrial refrigeration must result in a highly crystalline structure of the inner surface of the shell, as pointed out by Bischof and others, as well as to keep in view the dislocations that may from time to time occur, to immediately perceive that sufficient cause exists for producing such an amount of friction as would be effective, along with the pressure, in causing the shell and nucleus to rotate together nearly as one solid mass. The projection of great crystalline masses into the remaining fluid would thus, not only by increasing the tangential action between the nucleus and shell, account for the result I have adduced, but they would also give rise to a series of reactions producing disturbances in the superficial positions of the

Crystalline structure of the inner surface of the Earth's crust.

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[7] Phil. Trans. 1851, Part II. p. 524.

fluid, whenever, from any cause, a tendency should exist for the nucleus and shell to move with different velocities. Such a tendency would be in constant action from the very nature of the process of solidification, whereby matter is transported from the centre of the nucleus to its surface, and from the nucleus to the shell. These reactions may thus be effective in disturbing the surface of the fluid, so as to produce sensible undulations, and thus give rise to some portions of the phenomena of earthquakes.

Connexion of the preceding views with geological dynamics.

The influence of these results on such geological theories as attempt to explain the phenomena of the elevation and depression of the Earth's surface have not yet been fully developed. A great living geologist has endeavoured to account for many of these phenomena by the gradual subsiding of the solid shell upon the contracting nucleus within it. Thus, he maintains, ridges and protuberances would be produced at different epochs, so as to constitute the different chains of mountains scattered over the surface of the Earth. The structure of the central axes of the great mountain-chains of the world seems to indicate that portions of them have been often ejected from the interior in a liquid or pasty condition. Such fractures cannot always be traced in the rocky masses which form these axes as would necessarily indicate that they are merely the ridged edges of a great subsidence, and their appearance would frequently be much more easily explained by considering them as the results of the elevating forces originating in the pressures here adduced, gradually pushing forth through the broken shell certain portions of the imperfect fluid, which form the surface of the nucleus. The results to which I have been led seem to indicate that the reaction of the interior and still fluid nucleus upon the exterior crust of the Earth, takes place in such a way as might be applied to explain many of the interesting symmetrical relations of the configuration of our planet, which M. Elie de Beaumont has so ably and laboriously grouped together, in his work on the mountain systems of the globe.[8] In thus referring to M. Elie de Beaumont's researches, it will be readily understood that I am far from implying that all his conclusions are satisfactorily established. At the same time, there can scarcely be a reasonable doubt as to the existence of certain relations of a symmetrical character between so many widely distributed phenomena of elevation, belonging to the same or to successive geological epochs, as would indicate the operation of general and wide-spread disturbing agencies beneath the solid crust of our planet.

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[8] Notice sur les Systèmes de Montagnes. Paris, 1852.

Foldings and ridges of the Earth's crust capable of being produced by elevatory actions.

If some parts of an elevated district were fractured, while its other parts were still entire, it is easy to perceive how foldings and ridges would be produced, as well as in the system of subsidence. This view is further confirmed, by considering that the thickness of the solid shell of the Earth, although small compared to the Earth's radius, would soon be sufficiently great to enable the shell to stand of itself, independently of the support of the fluid nucleus beneath. It is true, that if both surfaces of the shell possessed ellipticities, such as they had when the matter composing them was in a fluid state, its smallest limiting thickness, at the present day, might be an evanescent quantity; for, with any thickness, the phenomena of the variation of gravity, of the inequality in the Moon's motion, and of precession and nutation, would be precisely the same, whether the Earth was fluid to its surface, or solid to its centre; but, as it already appears that if we admit a change of position in the particles composing the fluid in their passage to the solid state, the ellipticities of the inner and outer surface of the shell will follow a different law from that of the original fluid strata of equal pressure, we cannot immediately conclude that the limiting value of the present thickness of the Earth's crust is evanescent. I have attempted to assign a limiting thickness, which is also very small, but I admit that the calculations on this point require revision, for as yet we want some of the most important data. It will not suffice to take, as is usually done, the surface of equilibrium of the watery covering of the Earth, as the Earth's true surface, for by so doing, we would be already begging the question to be decided; we would be thereby tacitly assuming that the Earth's surface is perpendicular to gravity, an assumption from which the evanescent value of the thickness of its crust would immediately follow. The elegant manner in which Professor Stokes has deduced Clairault's theorem, shows, with remarkable clearness, that if we assume for the Earth's surface the characteristic property of a fluid surface, the variation of gravity and other statical and dynamical results of the Earth's figure and structure, will be the same, whatever may be its internal

The surface of equilibrium of the watery coating of the Earth not the Earth's true surface.

constitution. But if we consider the surface of the Earth as that surface which would be exposed to view by stripping off, not only its liquid covering, but the strata of sand, clay, and rock, which had evidently been deposited from water in a sedimentary condition on the outer surface of the solidified shell, we shall have a surface differing from that of the water covering of the spheroid. The immense elevated table-lands of central Asia and of the the New World, and still further, the great depressions of the bed of the ocean, revealed by recent soundings and tidal phenomena, sufficiently prove that the water surface is far from representing with certainty the true surface of the solid spheroid; and although the former is necessarily perpendicular to gravity, so far from being entitled to infer that the latter possesses the same property, we might very safely assume the reverse.[9] We may therefore fairly infer provisionally, that the thickness of the shell is not necessarily so extremely small as to be a negligible fraction of the Earth's radius, when considering the great statical and dynamical conditions of the Earth.

Inconclusiveness of Mr. Hopkins's estimate of the thickness of the Earth's crust.

The results obtained by Mr. Hopkins regarding the minimum thickness of the Earth's crust, which would be consistent with the observed amount of precession and nutation, having been sometimes referred to by geologists, it is right to add that these results are not at all conclusive. They are derived from a discussion of the values of the fraction $\frac{\varepsilon}{\varepsilon_1}$ contained in the expression already quoted. In order to estimate the value of this fraction, Mr. Hopkins tacitly assumes that the forms of the strata of equal density in the solid crust, including that of its inner and outer surfaces, are precisely the same as those of the fluid mass from which the strata had solidified; and in short, that the process of solidification of the globe was accompanied by no change whatever in the geometrical distribution of its particles. This assumption can now no longer be considered as tenable, consequently no conclusions as to the thickness of the Earth's crust can be derived from considerations of which it forms the essential foundation.

Difficulty of accounting for

With any but a very small thickness, it appears impossible that subsidence of the shell could take place in such a way as to account for the phenomena of elevation

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[9] These views have been further developed by the author in a paper read at the meeting of the British Association in Dublin.

the production of mountains, by subsidence of portions of the Earth's crust.

of mountains or plateaus on their edges. If any portion of the crust were unsupported by the nucleus, its tendency would be to support itself on the principle of the arch. We cannot compare its condition to that of a thin, unsupported, and brittle egg-shell, as has been done by M. Elie de Beaumont, for the attractions to which the solid shell of the Earth is subjected, acting very nearly perpendicularly to the tangent plane at any point of its inner surface, acts precisely in the direction best adapted for securing its stability. On the contrary, a small, round object like an egg-shell, at the Earth's surface, is subjected to parallel pressures, and is thus placed under more unfavourable conditions for stability.

Illustration from the equilibrium of arches.

If we consider two arches of equal dimensions and strength, one with a mass of fluid pressing down on its extrados, the other with a mass of fluid pressing upwards on its intrados, the head of fluid producing pressure in both cases being equal to the depth of the fluid over the first arch, it is manifest that the second arch would be far more readily burst upwards than the other would be crushed downwards. It is well known to engineers that arches made to sustain incredible pressures from above, may be easily "blown up" by a comparatively moderate pressure from below.

The pressures exerted by the fluid nucleus of the Earth against the solid crust, present adequate causes for phenomena of elevation.

The forces resulting from the expansion of the nucleus, and its pressure against the shell, are, as well as the action of gravitation, perpendicular to the tangent planes of the shell, but while the latter acts in the direction most favourable to stability, the former act in the direction most favourable to rupture, and would, therefore, be far more likely to be effective in producing disturbances of the Earth's crust, and above all the elevation of the lines of mountains, which impart such a peculiar character to its general configuration. In my *Researches on Terrestrial Physics*, I have in some measure considered the action of such a pressure, combined with another that would result from a tendency in the nucleus to change its figure, and I have shown that if the former happened to be small compared to the latter, a zone of least disturbance might exist on the Earth's surface, for the position of the boundaries of which formulæ are assigned. As no trace seems to exist of such a zone from geodesical measurements, I was led to infer that the general pressure predominated over the variable pressure, and, therefore, that lines of elevation on the Earth's surface should not present any marked relation of parallellism; either to the equator or to the meridians. It is satisfactory to find that this theoretical inference is confirmed by a conclusion of M. Elie de Beaumont, in the work already quoted. If the lines of elevation of the Earth's surface are grouped, so as to form, for the most part, a series of diametral lines to each figure of a network of regular pentagons, I cannot see any reason why such a symmetrical network might not be formed far more readily by the pressure of the nucleus acting outwardly against the shell, than by the subsidence of the latter inwards. The more regular and symmetrical the arrangements of the mountain systems, the more difficult it appears to reconcile them with mere subsidence, and the more easily do these arrangements seem to admit of explanation by the action of purely elevatory forces. The analogy between an interior, expanding, elevatory force, which separates the parts of a mass, and the molecular forces, which cause portions of certain rocks—for instance, basalt—to split into polygonal prisms, is far more clearly manifest, than between these phenomena and the crushing force which would accompany an action of subsidence. Lines of least resistance to separation or simple fracture, are more easily determined by the action of these forces, than lines of easiest crushing or squeezing, and greater symmetry might be fairly expected in the distribution of the former than in that of the latter.

ART. III.—*Note on the differences of level (seiches) observed by M. Stabrowski on Lake Onéga in Russia.* By HENRY HENNESSY.

THE phenomena briefly described by M. Stabrowski in the *Comptes rendus* of the French Academy for last July, present some relations of resemblance to those occurring on the surface of Lough Erne, the physical explanation of which is contained in a letter addressed by me to the President of the Royal Irish Academy, which appears in the Proceedings of that body.[1]

Both at Lough Erne and Lake Onéga, the abnormal condition of the surface of the water is due to atmospheric disturbance; but while in the former the action of the air seems to be entirely dynamical, in the latter its mode of action, and the resulting effects, present a statical character. The transitory wave of translation, which sometimes unexpectedly beats against one of the shores of our Irish lake, is due, as I have shown, to the action of descending currents of air from the hills at the opposite side; but Lake Onéga appears to act under changes of atmospheric pressure, like a differential barometer. It possesses all the conditions essential for this purpose, being long and narrow. The result is, that accidental differences of atmospheric pressure at its extremities would produce very observable changes in the water level. The rising of the water at one side of the lake is usually accompanied by a fall in the barometer, and *vice versa.* The *seiche* is always the precursor of wind [horizontal currents], and the oscillations of the surface of the lake enable the natives to foretell the direction and force of the winds.

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[1] Vol. vi., p. 279.

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ART. IV.—*On the formation of several Acids of the series* $C_nH_nO_4$, *by the Destructive Distillation of Peat.*[1] *By* WILLIAM K. SULLIVAN. *Being Part* I. *of the Chemical History of the Products of the Destructive Distillation of Peat.*

Action of heat upon animal and vegetable substances in close vessels.

WHENEVER we submit animal or vegetable substances to the action of heat in close vessels, we obtain three classes of products—gaseous, liquid, and solid. The gaseous products consist chiefly of carbonic acid, carbonic oxide, olefiant gas, and marsh gas. The liquid products consist of water holding certain liquid and some few solid bodies in solution. Another portion of the liquid products insoluble in water, and holding the chief part of the solid bodies in solution, forms a mass of a more or less oily or butyraceous consistence, known as tar. The bodies held in solution by the water and the constituents of the tar are very numerous and various. But their relative proportions, and in some respects their nature also, depend upon the kind of body submitted to distillation, and upon the temperature at which the distillation takes place. The latter circumstance, indeed, not only affects the constituents of the tar and the bodies held in solution in the water, but also the gaseous products. If the distillation be effected at a very low temperature, scarcely any or no gas will be produced; if at a very high temperature, abundance of gas, and scarcely any liquid or solid products, will be formed.

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[1] An abstract of the chief results contained in this paper was read at the Dublin meeting of the British Association, August 27, 1857.

Classes of bodies produced.

The liquid and solid products may be classified under four heads: 1. bases; 2. acids; 3. alcohols, ethers, and similar compounds; and 4. carbo-hydrogens. Bases are the result of the decomposition of azotic bodies, and their amount and number will therefore depend upon the quantity of nitrogen in the substances operated upon. Animal bodies, such as bones, blood, etc., will accordingly yield more than vegetable substances. The precise conditions upon which the formation of acids depends are not well understood; but it is evident that the substances which yield them must contain oxygen, if we except one, hydrocyanic acid, which contains nitrogen, and is accordingly formed most abundantly in the distillation of animal substances. The third class of bodies appear to be most readily formed from woody and amylaceous substances. The fourth are formed from all indifferently, though doubtless different kinds are produced from each substance distilled.

Effects of the variation of temperature of distillation.

Generally speaking, it would appear that the effect of increasing the temperature of distillation is to lower the atomic weight of the bodies produced. Thus, for example, at comparatively very high temperatures the bases consist almost entirely of ammonia; at still higher temperatures, even this will be in part converted into cyanogen or totally decomposed. At comparatively low temperatures, several of the compound ammonias will also be produced, such as methylamine, ethylamine, aniline, etc. Similarly, among the hydrocarbons resulting from distillation at a low temperature, we have a large proportion of solid bodies, and a large proportion of the liquid ones have very high boiling points. The hydrocarbons produced at a high temperature, on the other hand, are chiefly liquid; and we may even carry the temperature high enough to get them in great part as gases or liquids with extremely low boiling points, or even to decompose them altogether, and get as our chief volatile product marsh gas.

We know as yet too little about the circumstances affecting the production of the second and third classes of products, to speak positively upon the effect of temperature upon them; but there can be no doubt that it is similar to that exerted upon the bases and carbohydrogens.

Substances whose products of distillation have been studied.

The substances whose products of distillation have been hitherto studied, are wood, coal, bituminous shale, and bones. The first yields the largest proportion of bodies belonging to class 3; the latter appears to give the largest proportion of bases. The products of another substance, peat, can now be added. This substance stands intermediate between wood and coal, partaking of the character of the one or of the other, according as we operate upon the light moor peat, in which the vegetable structure of the plants from which it was formed is still visible, or upon the compact earthy peats, in which all trace of organized structure has disappeared. The products are probably more numerous and various than even those of wood, the more so because the temperature of distillation of peat is perhaps lower than that at which the distillation of any other bodies distilled on a manufacturing scale is effected.

Connection of present researches with a former technological investigation.

Mr. Rees Reece proposed, about seven or eight years ago, to effect the distillation of peat in a novel manner, with the view of obtaining certain of the products for commercial purposes. This process was made the subject of an investigation, in which I was engaged, while chemist to the Museum of Irish Industry, in the year 1850, and although of an altogether technological character, it afforded me during its progress an opportunity of seeing that the complete investigation of the products from a scientific point of view would be extremely interesting and important. Among the observations which I then made were, the detection of butyric acid, cyanide of ammonium, and cyanide of methyl, or acetonitrile C_4H_3N, among the products of distillation, and the probability of the presence of other hydrocyanic ethers or nitriles. These observations were not mentioned in the report of the investigation published as a parliamentary document in 1851, for several reasons, but chiefly because the analytical proofs being defective, I preferred omitting all mention of them until I could enter upon a thorough investigation of the whole of the products, after the technological part of the subject had been completed. Want of time and other causes prevented me, however, from resuming the subject until the present year. In the meantime the process of distillation has been carried out commercially, and I have thus been enabled to obtain sufficient quantities of the raw products to pursue the investigation with far greater chances of obtaining successful results, than I could have hoped for otherwise. Indeed, it would be perfectly impossible to investigate the subject at all, but for the facility of operating upon large quantities of materials.

In this and following memoirs on peat products, the acids, alcohols, and ethers will be first treated of.

As very little attention has hitherto been bestowed on the acids produced by destructive distillation, or their allied bodies, the alcohols and ethers produced by the same process, I purpose taking up this branch of the subject first, leaving the investigation of the bases and carbohydrogens to a later period. In this first instalment I shall confine myself chiefly to the results obtained with respect to that most remarkable and important class of acids having the formula $C_nH_nO_4$.

In order to understand the exact mode of occurrence of the several bodies to be described in this and succeeding memoirs, it will be necessary to briefly describe the process by which the peat is distilled on the great scale.

Description of process of distillation of peat.

The retorts employed for the distillation of the peat are unlike those used in any other process of distillation, being no other than ordinary High Furnaces, similar to those employed in iron smelting, and, like them, supplied with a blast of air, blown through three tuyeres by a cylinder blowing machine. Each furnace is capable of holding from fifteen to twenty-five tons of peat, according to its density, and is completely covered down, having a peculiarly-contrived hopper for feeding the furnace, and two outlet-pipes for conveying away the products of distillation and combustion into a main somewhat similar to that used in gas works, but somewhat differently disposed. Connected with this main is a peculiar refrigerator or condenser, consisting of a series of isolated chambers divided by diaphragms and connected by a series of upright pipes, and then a series of scrubbers, consisting of cylinders with several gratings, upon which rest successive layers of round pebbles, and through which water can be made to fall as a dense rain.

Distilling furnaces.

The furnaces being filled with peat and ignited, the blast is turned on, and the distillation proceeds. But there is combustion going on also; that is, the charcoal produced by the distillation is completely consumed by the blast of air blown in at the tuyeres. At this point an intense heat is produced, and the whole of the oxygen of the air is converted into oxide of carbon. This compound, together with the unaltered nitrogen of the air, both at a very high temperature, then pass up through the mass of turf in the furnace and char it, the products being carried forward by the blast through the outlet-pipes into the main, where the liquid and solid products are partly condensed; thence the current of gaseous matter passes through the condensers and scrubbers, where the remainder of the solid and liquid bodies are deposited.

It must be already apparent that no charcoal is obtained in this process, the whole of it being consumed in the bottom of the furnace, in order to supply heat to distil the fresh peat added from time to time through the hopper at top.

Temperature of distillation.

Notwithstanding that the distillation takes place in a blast of air, the process, so far as the products of distillation are concerned, does not differ in results from close distillation in ordinary retorts. The operation, too, is carried on at a very moderate temperature; for although that of the gases, as they ascend from the hearth where the combustion of the charcoal takes place, is extremely high, yet they become so rapidly cooled by the latent heat absorbed by the large quantity of water which must be evaporated from the turf (that generally used giving about 35 to 40, and sometimes even 50, per cent. of water by distillation), that the temperature at the top of the furnace scarcely ever exceeds 200° Cent., and in the outlet-pipes it rarely exceeds 110° Cent. The fresh turf is, in fact, partially distilled by a current of hot steam and gases in the upper part of the furnace; the complete charring being effected lower down by the hot gases alone.

If the volume and force of the blast be sufficiently increased, a bright red heat may be obtained in the upper part of the furnace, and even the outlet-pipes may become red-hot; but in practice the blast is so regulated that the temperature above stated is not exceeded Indeed the lower the temperature at which the process can be carried on, the greater will be the amount of those products which are of commercial importance. The process would be most perfect if no gaseous carbo-hydrogens were produced, that is, if all the hydrogen came over in the form of liquid and solid compounds.

Distribution of the products in the condensing apparatus.

A considerable part of the tar is deposited in the main, and a great part of the water also, the remainder of both is deposited in the condensers and scrubbers. From the latter the gaseous products, consisting of nitrogen, oxide of carbon, carbonic acid, marsh gas, a small portion of olefiant gas, and the vapours of some of the more volatile carbo-hydrogens, pass under the different boilers and stills, where they serve as fuel for the production of steam, etc. The water which collects in the main contains less of the volatile, liquid, or solid products in solution than that which is condensed at the end of the condensers and in the scrubbers, where the chief part of the methylic alcohol, ethers, etc., is condensed. The tar collected in the main is also more solid than that which is collected in the scrubbers, which is often semi-fluid or about the consistence of wood-tar.

Distillation of tar.

The tar deposited in the main and in the condensers is collected and subjected to distillation in a current of super-heated steam. The product which comes over consists chiefly of a number of liquid carbo-hydrogens of different boiling points, holding in solution a number of solid ones, that in greatest quantity being paraffine. There are also present a great number of other substances (bases, carbolic acid, etc.), but in comparatively small quantity. As the history of these products will form the subject of another paper, I will not further allude to them here.

Separation of ammonia and wood-spirit.

The quantity of water which distils over from turf is enormous, and consequently we may expect to find a large proportion of the solid and liquid products, which are soluble in water, in solution in it. The more abundant of these are ammonia, in combination chiefly with acetic acid and methylic alcohol. The ammonia and alcohol are capable of being separated in a state of more or less purity, and are consequently of commercial importance; but the acetic acid cannot be economically prepared, and is not consequently separated. The process of separating the methylic alcohol and ammonia consists in agitating the aqueous liquid with caustic lime, which combines with the acid bodies and sets the ammonia free. The liquid, after the undissolved lime and the resinous bodies, which form insoluble compounds with lime, have settled to the bottom, is distilled in a Coffey's still. The products of this operation are—1. an impure liquid, containing wood spirit and free ammonia, and a great number of other bodies, but in smaller quantity (bases, carbolic acid, acetic ether, nitriles, etc.); and 2. an impure brown liquid, containing the lime salts of the acids, which is allowed to run waste. The impure mixture of methylic alcohol and ammonia is treated with sulphuric acid sufficient to neutralize the ammonia, and again distilled. The sulphate of ammonia and other bases remain behind in the still, and are run off and evaporated in leaden pans to crystallize the sulphate of ammonia. The distillate contains the methylic alcohol and other neutral bodies.

Treatment of liquor containing acids.

Leaving the history of the bases accompanying the ammonia, and the bodies mixed with the methylic alcohol, as subjects for other subsequent papers, I will return to the waste liquor containing the lime salts. This liquor is so very dilute, that an immense volume must be evaporated in order to obtain sufficient of the mixed lime salts to be able to effectually separate the acids. Several hundred gallons were accordingly evaporated in a leaden pan, so as to reduce the whole to a small bulk. During the operation, a large quantity of pitchy or tarry matter separated, and was removed. The concentrated liquor was still further evaporated in the laboratory, generally until a pellicle formed on the surface. Sulphuric acid, diluted with twice its weight of water, was then added in sufficient quantity to decompose the lime salts; the whole was allowed to stand until the tarry matter, sulphate of lime, etc., had settled to the bottom, when the clear liquor was distilled.

The acid liquor which came over was usually somewhat milky, when the solution of lime salts had been evaporated to a pellicle before decomposition with sulphuric acid, otherwise it was clear and of a straw yellow or pale brown colour. When left exposed to the air for a few days, this colour changed to a dark reddish brown. The acid always smelled like a combination of the smell of vinegar with that of rancid butter, more or less masked, however, by the strong and disagreeable smell which pervades all peat products.

This acid liquor was neutralized with carbonate of soda, and concentrated by evaporation, and set aside until

Cyanogen formed during the distillation of peat.

a good crop of crystals of acetate of soda was obtained. These were removed and left to drain in funnels for some days; the drainings were added to the mother liquor, and the whole again concentrated by evaporation, and set aside to crystallize in a warm place for some days, during which a further crop of crystals of acetate of soda separated. The mother liquor drained from these crystals yielded a white precipitate with acetate of zinc, insoluble in water and alcohol, but readily soluble in cyanide of potassium. Treated with strong sulphuric acid and distilled, an acid liquor came over, having the characteristic odour of hydrocyanic acid. Some of this liquor, treated with a few drops of potash and then with a few drops of protosulphate of iron, containing a little persulphate, and heated, and then treated with a few drops of hydrochloric acid to dissolve the precipitated oxide of iron, yielded Prussian blue.[2]

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[2] Cyanide of ammonium appears to be always formed in the distillation of peat. But the quantity seems to be subject to considerable variation, being apparently greatest with dense dry turf distilled at a high temperature, and least with light wet turf distilled at a low temperature. According to M. Langlois *(Annal. de Chim. et de Phys., t.* lxxvi., *p.* 111), cyanide of ammonium is formed when dry ammoniacal gas passes over dry charcoal at a red heat, hydrogen being eliminated; but according to M. Kuhlmann (*Annal. der Chem. und Pharm., Bd.* xxxviii., *s.* 62), marsh gas is evolved in this reaction. Gerhardt (*Traité de Chimié Organique, t.* i., *p.* 305) gives the following equation, expressive of the change, in accordance with the results of Kuhlmann:

$$3 C_2 + 4 NH_3 = 2 [C_2 (NH_4) N] + C_2H_4.$$

Gerhardt also states, that if a mixture of oxide of carbon and ammonia be passed through a red-hot tube, cyanide of ammonium will be formed, thus:

$$2 CO + 2 NH_3 = C_2 (NH_4) N + 2 HO.$$

As the conditions required for the formation of cyanide of ammonium by either of these processes, but especially by that last mentioned, coexist in the interior of the furnace in which peat is distilled, we need not be surprised at its presence among the products of the distillation, or of the existence of several nitriles, or hydrocyanic ethers, among them also. The higher the temperature, too, within certain limits, the more favourable the conditions for the mutual decomposition of oxide of carbon and ammonia, a circumstance quite in accordance with the observation made above, that the quantity of cyanide appeared to increase with the temperature of distillation. In connection with this subject, I may mention some observations which seem to indicate that the action of oxide of carbon, at a high temperature, upon ammonia, is one of the chief sources of the formation of cyanide of ammonium in the distillation of peat. When turf containing about thirty per cent. of hygro-

Treatment of mother liquor after separation of cyanide of zinc.

The mother liquor, from which the cyanide of zinc was separated, was still further concentrated, introduced into a stoppered flask, and double its volume of dilute sulphuric acid (composed of one part of oil of vitriol by weight, and two of water) added, and the whole allowed to stand during the night in a mixture of salt and pounded ice. On the following morning nearly the whole of the sulphate of soda had crystallized out. The mother liquor was covered with a layer of an impure brown oil; this was removed with a pipette, and the mother liquor poured off. The latter was then partially saturated with carbonate of soda, as recommended by Liebig, in the process proposed by him for the separation of butyric and valeric acids by fractional distillation,[3] and distilled; the whole of the acetic acid remained behind, in the first trial with a small portion of one or more of the other acids; these small portions it was not thought worth while to attempt to separate farther. The distillate yielded a little more oil, which was added to the first quantity, and an extremely acid liquor, in which the smell of formic acid predominated. This liquor was somewhat diluted with water, divided into two portions, one of which was introduced into a stoppered flask containing freshly prepared hydrated oxide of copper, with which it was allowed to digest for some time. The remainder of the acid was then added in successive portions, the whole being well shaken, so as to take up any basic salts formed, and nearly, but not completely, neutralize the whole of the acid added. The solution was then filtered, to separate

Preparation of copper salts with aqueous product of fractional distillation.

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metric water is distilled in a closed iron retort, heated by gas or other fuel, the liquid which came over at the first period of distillation shows no trace of hydrocyanic acid, even when heated with sulphide of ammonium, and tested with sesquichloride of iron. Very little ammonia is formed in the early stages of distillation, and the liquor has even an acid reaction. When the mass approaches a dull red heat, ammonia begins to come over; and at a still higher heat, cyanide of ammonium may be detected, the gaseous mixture at the same time containing a good deal of oxide of carbon. As there is always abundance of oxide of carbon in every part of the furnace during the distillation of peat in a blast of air, the conditions are certainly more favourable for the production of cyanide of ammonium in this process, than when the distillation is conducted in closed vessels. Perhaps the cyanogen observed by Bunsen and Playfair, as a constituent of the gases of high furnaces in which iron is smelted with coal, is in part formed under similar conditions. Another source of cyanide of ammonium may also be mentioned, namely, the decomposition of methylamine and other compound ammonias, at a red heat.

[3] Annal. der Chem. u. Pharm., Bd. lxi., S. 355.

undissolved oxide and difficultly soluble copper salts of acids suspected to be present, and exposed to spontaneous evaporation in a warm place; a crystalline mass was left, which was crushed up and treated with alcohol; the undissolved residue was dissolved in water, and again crystallized by spontaneous evaporation. The salt obtained, crystallized in oblique, rhomboidal prisms, of a clear blue, and yielded, by distillation with phosphoric acid, an acid liquor having all the properties of formic acid.

Reactions of acid prepared from copper salt insoluble in alcohol, showed it to have been formic acid.

A small portion of it neutralized with soda, evaporated to dryness, and treated with some hydrate of baryta, left a residue containing oxalic acid, a reaction more or less characteristic of formic acid.[4] Another portion of the acid was treated with oil of vitriol, which decomposed it with evolution of oxide of carbon. Some drops of it, warmed with a solution of corrosive sublimate, threw down calomel, and on boiling the mixture for some time, metallic mercury was separated. The free acid did not give a precipitate with nitrate of silver; but a few drops, nearly neutralized with soda, crystallized on a watch glass, and dissolved in a very small quantity of water, so as to form a somewhat concentrated solution, yielded, with nitrate of silver, a white, difficultly soluble, crystalline precipitate, which soon darkened. On heating the mixture, the whole of the silver was reduced, and the fluid became black, from the finely divided silver in suspension. These different reactions showed that the substance was formic acid. In order to control these results by the determination of the atomic weight, the remainder of the acid was neutralized with carbonate of baryta, the solution filtered, and the filtered liquor set aside to crystallize. The crystals formed were drained, washed with distilled water, dissolved in water, and again crystallized over sulphuric acid. The crystals formed did not lose their transparency when exposed to the air.

Corroborated by determination of atomic weight.

0.715 grammes of the baryta salt dissolved in water, and precipitated by dilute sulphuric acid, gave 0.730 grammes of sulphate of baryta, =0.479 grammes of baryta, which corresponds to the following composition in 100 parts:—

	Calculated.	Found.
C_2HO_3,	32.550	32.906
BaO,	67.450	67.094

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[4] Peligot Annal. de Chim. et de Phys, lxxiii. 220.

The numbers found agree sufficiently well with the theoretical ones, considering the great difficulty of separating and purifying mixed acids of this kind, where the quantity of material to be operated upon is small; and in this case there was the additional difficulty of the presence in the crude acid of a great quantity of tarry matters, in the separation of which a good deal of material was lost.

Examination of oil.

The oil was next examined. It was agitated with chloride of calcium, to remove adhering water, and then distilled. The portion which passed over at temperatures under 140°, was collected apart; the operation was continued until the temperature rose to 160°, when the residue became quite thick and tarry, and nothing further could be done with it, as the quantity was too small to attempt the further separation of its constituents by other means. Having since obtained a much more considerable quantity of material, I hope to be able to separate the substances of a higher boiling point than 160°.

Oil boiling at 140° C.

The oil which came over at temperatures under 140° was partially neutralized with carbonate of soda, and distilled. The distillate consisted of an oily liquor, having a piercing, disagreeable smell, reminding one at the same time of rancid cheese and the smell produced in the boiling of soap. This oil was again distilled with a very small quantity of carbonate of soda, the temperature being carefully regulated by means of a fusible alloy bath. The distillate was a clear, oily liquid, which boiled at 140°, and distilled without change. It dissolved in water, the excess of oil floating upon the surface of the saturated solution. Carbonate of potash was added to this solution to neutralize it, and the whole evaporated to dryness. The dried mass was treated with anhydrous alcohol, which dissolved the potash salt, leaving the excess of carbonate of potash behind. The alcoholic solution of the potash salt was then treated with ether, which precipitated the potash salt in colourless

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[5] Among the many sources from which the formic acid present in the peat liquor may be derived, we may mention the hydrocyanic acid. It is well known that if we boil a solution of cyanide of potassium, we convert it into ammonia and formiate of potash. Even a solution of it in stoppered bottles gradually decomposes, carbonate and formiate being formed. During the boiling of the liquor containing the lime salts, the cyanide of lime must be also partially decomposed. This, though it must certainly be one of the sources of the formic acid, is not the only one.

Analysis of potash salt.

pearly scales, feeling fatty to the touch. This salt was employed to determine the composition of the acid.

0.650 grammes of this salt, dried at 130° and burned with oxide of copper, gave[6]

0.755 grammes of CO_2 (inclusive of that combined with the potash, which was supposed to remain behind as carbonate), and 0.262 grammes of HO.

0.345 grammes of the salt, dried at 130°, gave by treatment with SO_3HO, evaporation to dryness and ignition: 0.268 grammes of sulphate of potash = 0.145 grammes of potash.

These numbers lead to the following formula and composition in 100 parts:—

	Calculated.	Found.
C_6	32.085	31.678
H_5	4.456	4.478
O_3	21.392	21.816
KO	42.067	42.028
	100.000	100.000

Determination of atomic weight with baryta salt.

These numbers were further controlled by the determination of the atomic weight from the analysis of the silver salt. This salt was prepared by precipitating a solution of the potash salt with nitrate of silver: a white apparently crystalline precipitate was formed, which slightly blackened, and then partially decomposed on boiling the mixture for a few minutes. On cooling, the salt was deposited in warty grains, which, on examination with a lens, appeared to be composed of a peculiar arrangement of needles. By careful recrystallization from a dilute solution left to spontaneous evaporation for a few days, the salt was obtained in colourless needles.

0.415 of this salt, dried over sulphuric acid, gave 0.247 of metallic silver = 0.265 of oxide of silver, or in 100 parts,

	Calculated.	Found.
$C_6H_5O_3$,	35.912	36.074
AgO,	64.088	63.926
	100.000	100.000

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[6] In burning substances of this kind, and indeed all volatile bodies, or such as at a high temperature yield products of distillation which are

Propionic acid.

The formula resulting from this analysis is that of propionic or metacetonic acid $C_6H_5O_3,HO$.

Nöllner's pseudo-acetic acid,

not identical with metacetonic or propionic acid.

Some years ago Nöllner obtained an acid from the fermented mother liquor of tartrate of lime, which he termed pseudo-acetic acid. Nicklès analyzed the body and deduced the formula $C_6H_6O_4 = C_6H_5O_3$, HO, which is the formula of the acid obtained by Gottlieb by the action of potash or dilute sulphuric acid upon hydrocyanic ether or cyanide of ethyl (propionitrile), and which can also be obtained in several other chemical reactions. Nicklès, however, believed it to differ from the metacetonic acid. Dumas, Malaguti, and Leblanc,[7] considered the acid of Nöllner to be identical with metacetonic acid; both acids, besides possessing the same composition, are also identical in smell, boiling points, and in the appearance and properties of a great number of their salts, especially the baryta salt. The subject has been again examined recently by Limpricht and von Uslar,[8] who have come to the conclusion that the acid of Nöllner is really different

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liable to be carried forward into the chloride of calcium tube without being fully decomposed, I have found it advantageous to use a slight modification of the usual process. The tube is of considerable length. Some oxide of copper is moistened with nitric acid, and heated very strongly in a crucible, so as to get it into a hard, sintered mass, which, when powdered, has the advantage of not being so hygroscopic as the oxide of copper usually employed. This powdered mass is again heated, and when sufficiently cooled, the substance to be analyzed is mixed up coarsely with a little of it, and introduced into the tube, previously well dried. The whole is then covered with soft oxide, heated to 200° or 250°, and filled in out of the crucible itself in which it was heated, as recommended by Gerhardt, and the tube being corked, it is tapped, so as to shake the whole together. About four or five inches of the tube in front of the mixture is then filled up with small lumps of the sintered oxide previously heated to 200°, and put into the tube hot. The remainder of the tube, for about six inches, is then filled with copper turnings, whose surface has been oxydized by being exposed at a red heat to a current of dry oxygen gas. The combustion is proceeded with in the usual way, except that the part of the tube filled with copper turnings, and part of that filled with the lumps of sintered oxide, is first heated red-hot before the combustion commences, and is kept at that temperature to the end of the operation. In this way, any carbo-hydrogens which may be carried forward by the current of carbonic acid and vapour of water, must pass through a kind of sponge of oxide of copper, and over a very extended surface of oxydized copper at a red heat, and are completely burned. When the combustion is finished, the last traces of carbon may be burned away by passing a current of oxygen gas through the tube in the way described by Gerhardt, and which was first suggested by Laurent (Gerhardt's *Traité de Chimie*, t. i., p. 35). Generally speaking, this need not be employed, except in the case of very difficultly combustible bodies.

[7] Compt. rend., xxv. 781.

[8] Annal. der Chem. u. Pharm., Bd. xciv., S. 321 (1855).

from metacetonic acid obtained from cyanide of ethyl, etc.; one of the points of difference being that the propionate of potash is separated from its alcoholic solution in a crystalline state on the addition of ether, while the butyro-acetate is uncrystallizable. The acid obtained from the peat liquor corresponds, therefore, with true propionic acid, in the circumstance of its potash salt being precipitated as pearly scales from its alcoholic solution by ether.

Difference which they exhibit in their reactions.

By repeated distillations the butyroacetic acid may be resolved into butyric and acetic acids; but propionic acid, on the other hand, may be repeatedly distilled without its boiling point changing. If propionate of potash or soda be distilled with alcohol and sulphuric acid, and water be added to the distillate propionate of ethyle, a liquid lighter than water, and having a sort of fruit, or rather fermented fruit odour, separates. This liquid may be distilled without decomposition, its boiling point remaining constant at 101°. Butyroacetic acid, on the other hand, yields, under the same circumstances, a mixture of acetic and butyric ethers, which may be separated by fractional distillation, the former boiling at 74°, and the latter at 119°. A portion of the propionate of potash obtained from peat liquor, distilled with sulphuric acid and alcohol, yielded an ether boiling at 101°, and capable of distilling unchanged, and corresponding in every respect with propionic ether.[9]

Treatment of oil boiling between 140° and 160° C.

The portion of the oil which came over at temperatures between 140° and 160° was about three-fourths neutralized with carbonate of soda and distilled; the distillate was rejected. The residue in the retort was then distilled with sufficient hydrated phosphoric acid to decompose it; the distillate was agitated with chloride of calcium, and then about one-third neutralized with carbonate of soda, and again distilled. The distillate consisted of an oily liquid, having a faint yellow tint, but becoming darker on keeping. This is also the case with nearly every peat product, no matter what pains may be taken to purify it, probably from the presence of minute traces of some body which oxidizes rapidly and blackens. The oil was neutralized by baryta water, and evaporated to dryness at a very gentle heat, a few bubbles of carbonic acid being passed through the solution in the first instance, to convert excess of baryta into carbonate. The dried residue was dissolved in water, carefully filtered, and the solution set aside for some weeks during summer in a cellar. The greater part of the salt crystallized out in the form of lustrous flattened prisms, which were unaltered by exposure to the air, and melted at a temperature a little below 100° into a clear glass. Heated to 130°, they lost 18.64 per cent., which corresponds very nearly to 4 equivalents of water.

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[9] See a short paper, "Observations on some of the products of the putrefaction of animal and vegetable substances", at page 202 of this number.

Analysis of baryta salts.

I. 0.645 grammes of this salt, dried at 130°, and burned with chromate of lead, gave 0.730 grammes of carbonic acid, and 0.264 grammes of water.

0.330 grammes of the same salt, dried at the same temperature, gave 0.247 grammes of sulphate of baryta = 0.162 grammes of baryta.

II. 0.450 grammes, burned with oxide of copper, the salt having been first mixed up with phosphate of copper, gave 0.512 grammes of carbonic acid and 0.183 grammes of water.[10]

These numbers correspond to the following per-centage composition:—

		Found.	
	Calculated.	I.	II.
C_8	30.834	30.866	31.030
H_7	4.496	4.547	4.518
O_3	15.418	15.497	15.362
BaO	49.252	49.090	49.090
	100.000	100.000	100.000

Determination of atomic weight by silver salt.

These results were controlled by a determination of the atomic weight from the analysis of the silver salt. A dilute solution of the baryta salt was treated with nitrate of silver, and exposed to spontaneous evaporation. After some time pearly lustrous scales were formed, which were almost insoluble in cold water. They were well washed, and dissolved in boiling water. On cooling, the salt crystallized out.

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[10] It is well known that in the combustion of the baryta salts of several of the organic acids by means of oxide of copper, the baryta remains behind in the tube as carbonate, while in the case of the salts of several other acids, the whole of it does not remain as carbonate. This is the case with the acids of the series now under discussion. Lerch, in his investigation on the volatile acids of butter (*Annal. der Chem. u. Pharm.*, *Bd.* xlix., *p.* 216), accordingly proposed to mix the salt to be analyzed, before mixing it with oxide of copper, with from three to four times its volume of ignited phosphate of copper. He found that the whole of the carbonic acid was driven off from the baryta, when baryta salts were burned under such circumstances.

0.365 grammes of the salt, dried over sulphuric acid and ignited, left 0.201 grammes of metallic silver=0.216 grammes of oxide of silver. These results lead to the following numbers:—

	Calculated.	Found.
$C_8H_7O_3$,	40.513	40.853
AgO,	59.487	59.147
	100.000	100.000

Butyric acid.

These numbers represent the formula $C_8H_7O_3,HO$, which is that of butyric acid.

Constitution of butyrate of baryta.

The salt of baryta with four equivalents of water, which I obtained, corresponded with one of the salts described by Chancel, and which appears to have been also obtained by Pelouze and Gelis. Chancel stated that butyrate of baryta crystallizes either with two or four equivalents of water of crystallization, according as it is obtained from hot or cold solutions. When it crystallizes in the cold, it forms long flattened prisms perfectly transparent and containing 18.8 per cent. of water, or four equivalents. These crystals melt to a transparent liquid without losing weight when heated to a temperature below 100°. Crystallized from warm solutions, the salt contains 10.5 per cent. of water, or 2 equivalents, and does not melt at 100°. I had not enough of material to succeed in the preparation of the salt with two equivalents of water, having only obtained anhydrous crusts in every attempt which I made.

According to Lerch, butyrate of baryta appears in two different crystalline conditions, and in each is anhydrous; the one consists, as Chevreul has described, of mother-of-pearl-like plates and flattened flexible prisms; the other of hard granular crusts. The latter may, however, be converted into the former by repeated recrystallization. In either condition it did not melt at 100°. Lerch further states that he could not obtain butyrate of baryta other than in an anhydrous form.

It is difficult to account for the different results obtained by Chancel and myself, and by Lerch. The same difficulty occurs in the case of propionate of baryta, if the salt of Keller, with nine equivalents of water, be really a propionate, for all other statements agree in considering that salt as anhydrous. I have instituted some experiments with the view of discovering the cause of the anomaly in the baryta salts of both acids, as well as to determine more exactly the constitution of the butyrates and of the double salts which they form with the acetates, but the investigation is not yet sufficiently advanced to enable me to give any results here.

Acids of the series $C_nH_nO_4$, whose presence has been established.

The acids of the series $C_nH_nO_4$, or according to the notation of Gerhardt, the acids homologous to the radical $C_nH_{2n}-{}_1O$, which I have as yet succeeded in separating from peat liquor are accordingly:—

Formic Acid, ...	$C_2H_2O_4$
Acetic ,, ...	$C_4H_4O_4$
Propionic ,, ...	$C_6H_6O_4$
Butyric ,, ...	$C_8H_8O_4$

It is highly probable that several higher members of the series are present, and may be detected when a sufficient quantity of the mixed salts is operated upon.

Other acids found.

The acids not belonging to the last mentioned series, which have been found, are, *hydrocyanic* acid, and *phenic*, or *carbolic* acid, which is formed in very large quantities. It is probable that this class will also be much enlarged when larger quantities of raw material are employed.

This new source of the acids of the series $C_nH_nO_4$, rendered more interesting by Scherer's discovery of them in mineral waters.

Independent of the theoretical importance of this new source of the remarkable series of homologous acids, their occurrence as products of destructive distillation derives additional interest from the discovery by Scherer of several members of the series in the mineral water of Brükenau, in Bavaria.[11] There can be no doubt that the production of coal is nothing more than a *process of slow distillation*, and that all the substances which are obtained when wood or peat are distilled, are given off in the early stages of metamorphosis of coal-forming organic substances. The origin of the acids in the water of Brükenau is probably the slow decay of subterraneous vegetable matter, perhaps a bed of lignite or brown coal. I shall have some further observations to make on this relation between destructive distillation and the formation of coal in the subsequent papers of this series.

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[11] Annal. der Chem. u. Pharm., xcix., S. 257.

ART. V.—*Observations on some of the Products of the Putrefaction of Vegetable and Animal Substances, and their relation to Pathology. By* WILLIAM K. SULLIVAN.

A BRIEF summary of the observations which form the subject of the following communication, was appended as a note to a paper which I read at the Dublin Meeting of the British Association, and which is printed in the present number of this journal ("On the formation of several of the acids of the series $C_nH_nO_4$, by the destructive distillation of peat"). It had already been put into type in its original shape, when it struck me that the subject being of so much importance, especially in a physiological point of view, my observations might not prove uninteresting, if somewhat extended, and the analytical details added. Such an extension was incompatible with the limits of a note, and I have accordingly made a distinct communication of it.

Mass of wheaten flour set to putrefy several years ago.

Several years ago, I made between thirty and forty pounds of wheaten flour into dough with distilled water, placed it in an earthen pan, covered it with distilled water, and placed in the water and over the mass of dough an inverted funnel, the neck of which communicated by means of a narrow glass tube with the top of a tall narrow bell glass provided with a stop-cock, and inverted over some mercury in a basin. The whole apparatus was laid aside in a cold damp cellar for one year; during this period the mass swelled up, bubbles of gas where evolved which collected in the funnel, and could be made to pass into the bell glass from time to time by opening the stopcock. The gas collected in this way consisted almost entirely of carbonic acid, but small quantities of marsh gas C_2H_4 and uncombined hydrogen were obtained. Sulphide of hydrogen did not appear to have been given off at any period of the putrefaction; a piece of paper dipped into acetate of lead, suspended in the bell glass for days, did not exhibit the slightest blackening. Protochloride of mercury or basic acetate of lead was not precipitated black by the water standing over the dough.

Gases evolved during putrefaction.

Changes produced in mass

Very soon after the dough was placed in the water the putrefaction set in, but its energy gradually diminished according as the liquor became acid. At the end of the

by putrefaction.

year the greater part of the mass appeared to have undergone but little true decomposition. Nevertheless, the gluten throughout the whole mass had undergone considerable physical change. It had lost much of its tenacity, the external portion especially forming a soft slimy mass in which quantities of starch globules more or less unaltered were imbedded. A portion of the gluten taken from within about an inch of the surface of the mass, and freed from all adhering starch, was digested with water slightly acidulated with hydrochloric acid at a temperature of 22° C. until it dissolved. This solution examined with a polarimeter presented the power of left-handed deviation in a very feeble degree, compared with a solution of an equal degree of strength made with fresh gluten.

Slowness of putrefaction shown by a second experiment to be owing to the formation of acids in the liquor.

Experiments not being proceeded with, the chlorides of bases and baryta salts of acids preserved.

At the end of the second year the appearances were but little altered, and it was quite remarkable how little the putrefaction had progressed. That this retardation was caused by the presence of acids in the liquor, was very clearly demonstrated by another experiment made with flour mixed up with ground chalk, and then made into dough and placed in water beside the other mass. In the course of a few months the mass had putrefied more than the other had done after the lapse of two and a half years. In this case a little sulphide of hydrogen appeared to have been formed. Circumstances prevented me from continuing the experiments after this period. But being anxious to determine the nature of the substances dissolved in the water of the flour putrefied without chalk, I placed the whole mass upon a linen strainer, and when it had thoroughly drained, I mixed the mass on the filter with a large quantity of distilled water, allowed the solid part to subside, and decanted off the supernatant liquor, which was then added to that which had drained from the mass. This liquor was mixed with baryta water and distilled until the greater part of the liquor had passed over. The latter was very weakly alkaline; it was neutralized with hydrochloric acid and evaporated to dryness, at first on a sand bath, and lastly over a water bath. This dried mass was then preserved in tubes. The residue in the retorts was then removed, some carbonic acid passed through it, boiled, filtered, and evaporated to dryness, and the dry mass preserved in tubes.

Experiment on

While these experiments were in progress I also allowed a mass of brain to putrefy under exactly similar putrefaction of brain.

circumstances. In this case the putrefaction set in with great rapidity, and continued uninterruptedly for several months, because here the liquor never became decidedly acid. Both sulphide and phosphide of hydrogen were evolved during the decomposition of the mass.

Several bases formed during putrefaction of brain.

A very superficial examination of the acid, basic, and other products contained in the liquid in which the brain had putrefied, made at the time, and among which I found valeric acid in comparatively large proportions, and what I believed to have been trimethylamine and some peculiar compound containing phosphorus, led me to believe that a considerable number of the ammonia bases are produced during the slow decay of vegetable and animal substances.

Experiments resumed during the past year.

Having been engaged during the past year in searching for similar bodies among other products, I determined to examine the chlorides and baryta salts from the putrefaction of the flour, which I had carefully preserved in tubes, as above mentioned, but which I had not had time to analyze. The following is a summary of the results which I obtained.

Fractional distillation of mixed chlorides into three portions.

The dried mass presumed to contain the mixed chlorides of several bases, was treated with absolute alcohol, which dissolved a portion of it; the residue was common chloride of ammonium, as was fully established by a determination of the platinum in the precipitate formed by the addition of chloride of platinum and alcohol to a solution of it. The alcoholic solution separated from the chloride of ammonium was evaporated to dryness; the dry mass was introduced into a retort and a quantity of baryta dissolved in water added, equivalent to what would be required to saturate one-third of the acid contained in a quantity of common chloride of ammonium equal in weight to the dry mass put into the retort. The mass was then heated in a water bath, the product of distillation received into water acidulated with hydrochloric acid, the solution thus obtained evaporated, and the resulting dry mass, which I shall call A, preserved for further examination. As much more baryta was added to the residue in the retort and a second product, B, obtained. A third portion of baryta was then put into the retort and a third product, C, found.

Fractional distil-

The product called A was fractionated in exactly the same manner that the whole mass had been, the distillate being subdivided into three portions, *a*, *b*, *c*. The portion *a* was dissolved in the smallest possible quantity of water; bichloride of platinum was then added, and a mixture of alcohol and ether which threw down a double salt possessing all the properties of the ordinary platinochloride of ammonium. A determination of the platinum in this salt verified the supposition that the substance operated upon was almost wholly chloride of ammonium.

lation of portion A.

Preparation of salts of palladium and gold with the product *b*.

A portion of the product *b* was dissolved in water and treated with bichloride of platinum and alcohol, but scarcely any precipitate could be obtained. The whole was then evaporated to dryness in a water bath, but it was found so difficult to effect a separation of the pure compound, that I had to have recourse to the combinations with other metals. Another portion was treated with protochloride of palladium, but although a beautiful salt was formed, considerable difficulty was experienced in separating it in a pure state. Having dissolved the remainder of the product in the smallest possible quantity of water, a very concentrated solution of terchloride of gold was added, which threw down a yellow precipitate that dissolved on the addition of a mixture of ether and alcohol. The solution thus formed was exposed to spontaneous evaporation in a warm place, but shaded from the light. A number of small short rectangular prisms separated, which dissolved with difficulty in cold water; but freely in boiling water, though not without suffering slight decomposition if boiled for some time. This difference of solubility afforded a means of obtaining the salt in a comparatively pure state; the crystals were accordingly dissolved in a small quantity of boiling water; on cooling the compound crystallized out. The proportions of gold and chlorine in these crystals were determined by introducing a weighed quantity of them into a small flask, adding some granulated zinc and one drop of diluted sulphuric acid, and allowing the whole to digest for some time. When all the gold was precipitated, the supernatant clear liquid was decanted off, and the residue repeatedly washed by decantation. The precipitated gold was treated with dilute nitric acid in order to dissolve the excess of zinc; the solution was decanted off and added to the previous liquor, and the gold repeatedly washed by decantation as before. When fully washed it was transferred to a small porcelain cup, dried in a water bath, gently ignited, and weighed. All the li-

Mode of determining the amount of gold and chlorine in gold salt.

quids obtained in the washing of the gold were then placed in an evaporating basin, and a little milk of lime added, and the whole evaporated in a water bath to dryness to expel the volatile base. The dried residue was boiled with water, the solution filtered, and a few drops of nitric acid added so as to carefully neutralize the lime; it was then heated to boiling, and nitrate of silver added, to precipitate the chlorine. The milk of lime used, was prepared from lime made with white marble; before being used it was slacked and then mixed with a large quantity of pure water, allowed to settle, the clear liquid decanted off, and fresh water poured on, this operation being repeated three or four times so as to separate any chlorine which might be present. 0.115 gramme of the gold salt all treated in this way gave 0.056 gramme of metallic gold, and 0.165 gramme of chloride of silver. These numbers lead to the conclusion that the body under examination was the aurochloride of trimethylium, $N(C_2H_3)_3,HCl,AuCl_3$, as will be evident from the following comparison:

The base in the portion *b* was trimethylamine.

	Calculated.	Found.
$N(C_2H_3)_3H$	15.074 . .	
Cl_4	35.600 . .	35.441
Au	49.326 . .	48.695
	100.000	

Examination of B.

Preparation of platinum salt.

The dried mass B was fractionated in the same manner as A, into two portions. The first portion consisted chiefly of chloride of ammonium and chloride of trimethylium. The second portion was dissolved in a small quantity of water; a few drops of alcohol were added, and then a solution of bichloride of platinum, as long as any precipitate was formed. The whole was allowed to digest in the liquid for about ten minutes, and was then filtered to separate the precipitate. The latter was treated with boiling water, which dissolved it. When the solution cooled it crystallized out as golden scales of great brilliancy. 0.152 gramme gave on ignition 0.051 gramme of metallic platinum; 0.90 gramme digested with granulated zinc, and then boiled with lime-water, filtered, a few drops of nitric acid added, and the chlorine precipitated by nitrate of silver, gave 0.133 gramme of chloride of silver. These numbers correspond to platinochloride

The base

of amylium, $N\left\{\begin{matrix}C_{10}\,H_{11}\\H\\H\end{matrix}\right\}HCl.\ PtCl_2$, as the following comparison shows:—

was amylamine.

	Calculated.	Found.
$N(C_{10}H_{13})H$	30.046	
Cl_3	36.290	36.503
Pt.	33.664	33.552
	100.000	

The solution from which the foregoing salt crystallized out, was still further concentrated at a very gentle temperature and shaded from the light; a very concentrated solution of bichloride of platinum was then added, and the whole set aside in the dark for some days. During this time a crystalline precipitate separated, which was dissolved in boiling water; on being set aside until next day, a quantity of deep orange yellow tabular crystals deposited, but mixed with some of the golden scales of the last salt, and what appeared to be the platinum compound with common ammonia. The whole mass was accordingly digested with zinc, and the solution boiled with baryta water in a small retort connected with a bottle containing water kept cool by ice. The weak alkaline solution thus obtained was about one-third neutralized with hydrochloric acid, and distilled at a very moderate temperature; the product thus obtained was then about two-thirds neutralized with hydrochloric acid, and evaporated to a very small quantity; this was then divided into two portions, to one a strong solution of bichloride of platinum was added, and a few drops of alcohol, a slight precipitate was thrown down, which was separated by filtration; re-dissolved in water and set aside, it crystallized in fine scales. The mother liquor was set aside for some days, when the orange yellow tabular crystals again formed, but still mixed with a small quantity of some other compounds. The whole quantity, amounting 0.125 gramme, was burned, and gave 0.049 gramme of metallic platinum = 39.200 per cent. The body having the nearest composition to this would be platinochloride of ethylium, $N\left\{\begin{matrix}C_4\,H_5\\H\\H\end{matrix}\right\}HCl,\ Pt\,Cl_2$, which contains 39.300 per cent. of platinum.

Treatment of the mother liquor from which the platinum compound of amylamine was separated.

The base present in largest quantity was ethylamine.

Gold salt of ethylamine. The gold salt was prepared with the other portion of the chloride: it consisted of fine bundles of lustrous golden orange prismatic needles, but containing a little of another gold salt mixed with it. With the extremely small quantity of material at my disposal, I found it impossible to purify a sufficient quantity of the salt for an analysis.

C contained several bases. The portion marked C, from the first fractioning of the chlorides, apparently contained several bases; but I had not enough substance to enable me to prepare the platinum or gold salts in a state of purity.

Bases found, trimethylamine, etc. The only bases, accordingly, whose presence I was able to determine with certainty, were, trimethylamine, ethylamine, and amylamine.

Baryta salts yielded acetic, butyric, and valeric acids. The baryta salts were treated by Liebig's process of fractional distillation, and in other respects in the manner described in my other paper, already referred to; it is therefore unnecessary to describe the process here. The only acids which I could detect were acetic, butyric, and valeric; several higher members of the series are undoubtedly formed by putrefaction; but it would require to operate upon a very large quantity of material in order to be able to separate them. **Formic acid probably present.** I am also disposed to think that formic acid is also produced by putrefaction. The results which I obtained, although rendering its existence very probable, do not entitle me to pronounce positively upon its presence.

Negative character of evidence as to the presence of propionic acid. With regard to the presence of propionic acid, my experiments are rather of a negative character, and certainly do not lead to a definite result. On distilling one of the soda residues (resulting from the partial neutralization of the mixed acids, with a view of separating acetic acid) with phosphoric acid, neutralizing the distillate with baryta, and crystallizing the baryta compound two or three times, which was a matter of considerable difficulty, a salt was obtained having the exact appearance of propionate of baryta. When a solution of this salt was decomposed by carbonate of potash, the solution filtered, evaporated to dryness, and the residue treated with absolute alcohol, no crystalline salt could, however, be separated by the addition of ether, which, it is to be presumed, would be the case if propionic acid was present.

Propionic acid It is probable that the acid which has been obtained by the putrefaction of lentils, peas, etc., by Bœhme,[1] and which Dessaignes and Chautard[2] believe to be present in spent tanners' bark, may be the butyroacetic, and not true propionic acid, which does not appear to be readily formed in processes of putrefaction. When mangel wurzel or other varieties of beet are stored in heaps, and happen to heat and decay, a good deal of butyric acid is sometimes formed; but I was never able to detect propionic acid, nor could I in putrefied beet juice, although I have operated on a large quantity. F. Keller, nevertheless, states[3] that propionic acid is the predominating acid formed when bran is fermented with animal tissues; indeed, he says the only acids he obtained were acetic and propionic acids. According to him, propionate of baryta contains nine atoms of water of crystallization, which it loses on being heated to 140°. This statement is opposed to the usual opinion that propionate of baryta is an anhydrous salt. Frankland and Kolbe distinctly state[4] that propionate of of baryta dried at 100° has the formula, $BaO, C_6H_5O_3$.

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[1] Jour. für Prakt. Chem., xli, 278, (as quoted in Gerhardt's *Traite de Chim.*, *t.* ii., *p.* 440).

not readily formed during putrefaction.

Keller states that he obtained it.

Strecker[5] observes, that the mixed salts of acetic and butyric acids could be mistaken for propionates, and that the formation of propionic acid in the fermentation of bran, as mentioned by Keller, is by no means proved. He, however, obtained a large quantity of that acid under circumstances which certainly show that it can be formed during putrefaction, if not in the first stages, at least as the result of secondary reactions. In making lactic acid by the modified process proposed by Bensch, that is, by mixing together water, sugar, sour milk, and cheese, the mixture was left for two or three months in a place in which the temperature varied from 20° to 0°. There was formed at the end of this time, besides lactate of lime, a considerable quantity of mannite (as much as 1lb. from 10lbs. of sugar). On allowing such a mixture of lactate and mannite to remain during a summer at a temperature reaching to 20° or 22°, the lactate of lime gradually dissolved, and the evolution of gas continued. After standing for a year, the mass was treated according to Bensch's process for separating butyric acid, but none could be found; the only acids obtained being a large quantity of propionic acid, a small quantity of valeric acid (derived from the cheese), and acetic acid.

Strecker thinks the mixed salts of acetic and butyric acids could be mistaken for propionates.

He obtained it himself however.

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[2] Journ. de Pharm., xiii., 244.
[3] Annal. der Chem. u. Pharm., lxxiii., 205.
[4] Annal. der Chem. u. Pharm., xcii. 80.
[5] Annal. der Chem. u. Pharm., lxv. 288.

Great interest in a pathological point of view, which the formation of compound ammonia by putrefaction presents.

The formation of compound ammonia bases in the process of putrefaction is of great interest in a pathological point of view. Indeed I was originally led to institute the foregoing experiments from the belief that such investigations would throw light upon many pathological changes, and from the conviction that the ammonia which is said to exist in the blood in typhus, scarlatina, variola, cholera, and other diseases, is a product of decomposition, and would be found to be oftentimes a mixture of methylamine and other compound bases with common ammonia. That this is the case in the last stages of yellow fever, when the quantity of ammonia (part, at least, being in the state of chloride of ammonium, a body which could scarcely be the result of the decomposition of urea), becomes very considerable, I have not the least doubt.

Discovery that leucine can be formed in the living body.

In the year 1848, I showed[6] (I believe for the first time) that leucine could be formed in the living system, and that, too, without scarcely any organic disease. That body is always a product of the putrefaction of substances containing nitrogen, especially when it takes place under water, and I am consequently inclined to look upon its presence in animal secretions as a proof of putrefactive changes having set in. It is also probable that in every case where leucine is formed during putrefaction, compound ammonia bases will also be found if sought for. Whether this was the case in the liquid in which I observed the leucine, I could not, of course, determine; but it is worthy of remark that creatine was found in comparatively large quantity, while there was but little urea present. Since my discovery of this remarkable substance in an animal secretion, it has been found by several other observers. Frerich and Staedeler, for example, observed it in the human liver, after acute atrophy of that organ, after typhus, etc.;[7] Scherer also found it in the liver of a drunkard who had died of typhus.[8] Gorup-Besanez observed it in normal ox-liver, and also in the pancreas of that animal;[9] a similar observation has been made by Wolff,[10] who, in addition to a large quantity

Fact confirmed by other observers.

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[6] Proceedings of the Pathological Society of Dublin. Session 1847–1848, p. 29.

[7] Wien. Med. Wochenschrift, 1850, No. 30, quoted in Gmelin's Handbuch der Chemie (Fortsetzung), Bd. xiii. 2te. Hälfte, S. 75.

[8] Arch. f. Path. Anat., x., S. 228—230.

[9] Annal. der Chem. u. Pharm., xviii. S. 1—43.

[10] Arch. f. Path. Anat., x., S. 228—230.

of leucine, also detected the presence of a homologue of it. Virchow and Frerich have also found leucine in fresh pancreatic juice and in the glands themselves. Most of these observers believe that it is a normal product of the organism; but Virchow[11] has observed it to form and increase after death, and consequently looks upon it as a cadaverous product. That it is found in the living organism is, however, placed beyond doubt by my observation. But on the other hand it is doubtful whether it is ever produced by the healthy action of the organs. That it is a product of decay, though formed within living tissues, is, I think, supported by the circumstance that Gorup-Besanez found several of the acids of the series $C_nH_nO_4$ accompanying it in the liver; and in the mother liquor of the pancreatic tissues from which the leucine was separated, he observed the characteristic smell of the same acids on the addition of sulphuric acid. In connection with this point it would be of interest to determine whether tyrosine and hypoxanthine, which Wolff found in large quantities in the pancreas of the ox, and Scherer in the liver of the drunkard above mentioned (he finds hypoxanthine in all human livers), are always formed during putrefaction along with leucine. Gorup-Besanez found no tyrosine in the liver of the ox, and he thinks the presence of hypoxanthine doubtful.

Is probably always a product of decay.

Are tyrosine and hypoxanthine always formed during putrefaction?

Immediately after Wurtz's discovery of methylamine and ethylamine, I sought for them in several diseased secretions, but did not get any very decided results. I obtained, however, from the sweat of a patient suffering from bromidrosis, a small quantity of ammoniacal chlorides, which yielded, with bichloride of platinum and also with terchloride of gold, crystalline compounds, which appeared when examined under the microscope, to consist of at least three different forms of crystals. I determined the amount of platinum in the mixed salts, and found that the atomic weight of the base or bases was much higher than that of common ammonia. Here also, as in ordinary perspiration, the greatest part of the organic matter consisted of volatile acids—formic, acetic, butyric; but in addition to them, I obtained crystals of baryta salt, which had what appeared to me the exact form of caproate of baryta. These acids, as Lehmann has shown,[12] are not the

Probability of presence of compound ammonias in sweat, etc.

Caproic acid probably present in sweat.

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[11] Arch. f. Path. Anat., viii., S. 335—363.

[12] Lehrbuch der Physiologischen Chemie, 2te Auf. 1str Bd., S. 57.

products of the decomposition of the sebaceous substance. The fact of their occurring in normal sweat is apparently opposed to the idea that they are products of putrefaction; but in the present state of our knowledge, no decided opinion can be formed as to how far the presence of the acids of this series can be considered as an indication of putrefaction.

Importance of determining the condition under which compound ammonias are formed in the blood.

Other occupations have hitherto prevented me from pursuing this kind of research; and I do not know whether any one else has turned his attention to the subject. It would undoubtedly be of the greatest importance to determine the pathological conditions under which salts of ammonia are developed in the blood, etc., and whether the compound ammonias are formed in every case where common ammonia is produced. Such investigations would be very much facilitated by a good microscopical investigation of the forms of the platinum, palladium, and gold salts of the ammonia bases, and the publication of a good series of photographic views illustrative of them.

Probability that phosphorus bases are formed during the putrefaction of the brain.

It is also possible that some of the phosphorus bases discovered by Paul Thenard, and which have formed the subject of a recent admirable memoir by Hofman and Cahours, may be formed by the putrefaction of the brain and nervous matter. I hope to be able to resume my experiments on the putrefaction of the latter bodies immediately, and this time on a sufficient scale to enable me to separate most of the substances formed.

SCIENTIFIC NOTICES.

PHYSICS.

1.—*On the Thermal Effects of Fluids in motion.* By Professor W. Thomson and J. P. Joule, Esq.[1]

These researches were made on bodies moving through air with velocities carefully measured by a whirling apparatus. The thermometers in use were filled with ether or chloroform, and were so graduated as to exhibit changes of temperature in extremely small divisions of the centigrade degree. It was thus found that a thermometer having a bulb nearly one inch in length and a quarter of an inch in diameter, would have its temperature raised 1° centigrade by a velocity of 163·7 feet per second. Another thermometer with a much more voluminous bulb, had its temperature raised to a corresponding amount by a velocity of 183·5 feet per second. On wrapping the thermometers successively with paper and with metallic wires, the effect of motion on temperature was considerably increased. With wire the effect was quintupled at slow velocities, thus rendering manifest the influence of fluid friction.

The authors have, on several occasions, noticed the effect of sudden changes in the force of the wind on the temperature of a thermometer held in it. Sometimes the thermometer was observed to rise, at other times to fall, when a gust came suddenly on. When a rise occurred, it was seldom equivalent to the effect, as ascertained by the foregoing experiments, due to the increased velocity of the air. Hence they draw the conclusion that the actual temperature of a gust of wind is lower than that of the subsequent lull. This is probably owing to the air in the latter case having had its *vis viva* converted into heat by collision with material objects. In sheltered situations, such as one or two inches above a wall opposite to the wind, they observed that a thermometer indicates a higher temperature than it does when exposed to the blast.

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[1] Proceedings of the Royal Society, No. 27.

2.—*On the Influence of Temperature on the Elasticity of Metals.* By M. Kupffer. *And on the Thermal Effects of Longitudinal Compression of Solids.* By J. P. Joule, Esq.

The results obtained by M. Kupffer are printed in the *Compte rendu* of the Physical Observatory of St. Petersburg. He finds that heat influences both the transverse and torsional elasticity of wires and rods of different metals. The decrease of elasticity for every degree (Reaumur) of increase of temperature is calculated by a formula containing terms deduced by observing the oscillations of rods at different temperatures. Thus, for silver, he finds a decrease of elasticity of 0.000568; for wrought iron, 0.0004696; Platinum, 0.00020110; plate glass, 0.0001242; Swedish iron, 0.0004555; English rolled hoop iron, 0.0004416; copper, 0.0005570; lead, 0.0003035. With high temperatures the loss of elasticity became a little greater.

Mr. Joule[2] finds that heat is evolved by compression, and absorbed on removing the compressing force, in every substance he experimented on. In the case of metals the results agree very closely with the formula in which the longitudinal expansion by heat under pressure is considered the same as the expansion without pressure. He found that the experimental results were generally a little in excess of those calculated, thus indicating what M. Kupffer's researches had already established, namely, that the elastic force of metals is impaired by heat. Professor Thomson has appended some valuable remarks on the alterations of temperature accompanying changes of pressure in fluids, from which it appears that pressure generally increases in a slight degree the temperature of fluids, and that this increase is greater the higher the temperature of the fluid operated upon.

3.—*On the Electro-Dynamic Qualities of Metals.* By Professor W. Thomson.

The author had already communicated to the Royal Society[3] a description of experiments by which he found that iron, when subjected to magnetic force, acquires an increase of resistance to the conduction of electricity along, and a diminution of resistance to the conduction of electricity across, the lines of magnetization. By some experiments made recently, he has ascertained that the electric conductivity of nickel is similarly influenced by magnetism, but to a greater degree, and with a curious difference from iron in the relative magnitude of the transverse and longitudinal effects. Thus, with the same magnetic force, the effect of longitudinal magnetization in increasing the resistance, is from three to four times as great in nickel as in iron, while the diminishing effect of the transverse magnetization is nearly the same in the two metals. In connection with the comparison it may be observed, that nickel was found by Faraday to lose its magnetic inductive capacity much more rapidly with elevation of temperature, and must, consequently, as the author has elsewhere shown,[4] experience a greater cooling effect with demagnetization, than iron at the temperature of the metals in the experiments above mentioned. Professor Thomson further observes, that it will be very important to test the new property for each metal at those higher temperatures at which it is very rapidly losing its magnetic property, and to test it at atmospheric temperatures for cobalt, which, as Faraday discovered, actually gains magnetic inductive capacity as its temperature is raised from ordinary atmospheric temperatures, and which, consequently, must experience a heating effect with demagnetization, and a cooling effect with magnetization.

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[2] Proceedings of the Royal Society, No. 27, p. 564.

[3] Bakerian Lecture on the Electro-Dynamic Qualities of Metals, Feb. 27, 1856, in the Philosophical Transactions.

The present experiments, from the oblong form of the specimens of the metals used, do not admit of founding a quantitative comparison upon them; but the author hopes before long to be able to make a strict comparison between the effects for iron at least, if not for nickel also, and to find for each metal something of the law of variation of the conductivity with magnetizing forces of different strengths.—*Proceedings of Royal Society*, vol. viii., No. 27, p. 550.

4.—*Optics and Painting.*

M. Jamin has published in the *Revue des Deux-Mondes* during the past year some remarkable and highly interesting views on the connection of optics with the art of painting. As Mr. Ruskin's views on landscape painting have been received with considerable favour in these countries, and as many artists are more or less tinctured with the opinions of the realistic school, we thought it might prove useful to give the following abstract of these views, which we translate from that published by the Abbé Moigno in *Cosmos.*

When an artist desires to imitate a scene containing unequally distributed masses of light and shade, he is obliged to attribute to each of them its real value. He must, therefore, measure, or at least estimate, the brilliancy of different objects or of different surfaces, and graduate them in his copy according to the same proportional scale as in the model. For this purpose, he possesses an eye more or less exercised, which, however, as in other men, is a powerless instrument for the exact comparison of luminous intensities. He is, moreover, obstructed by the imperfection of resources of the art of painting; for nature generally presents an absolute brilliancy that no colouring could imitate. Unable to make his picture as perfect as nature, he is forced to darken it; but, for accuracy, he should at least maintain harmony and proportion of lights; that is to say, weaken all the lights in the same proportion. On this condition alone will his representation be true and faithful. How far has this condition been fulfilled in the most celebrated pictures? in other words, how far are the master-pieces of art true to nature? This is the problem M. Jamin has proposed for solution by the aid of optical science.

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[4] Nichol's Cyclopædia of Physical Science, article "Thermo-Magnetism".

More fortunate than the painter, the optician, knowing the imperfections of the eye, has invented photometrical apparatus, by which he can compare the brilliancy of neighbouring objects, and numerically express their relative illumination. By the aid of such apparatus, for instance, he ascertains that the shadow of a stick cast upon white paper has a twentieth of the brilliancy of the portions directly illuminated by the sun. M. Jamin himself has invented one of these precious instruments, of which we shall try to give a general idea. Imagine a small telescope like a single-barrelled opera glass. By putting the eye at the front we see that its interior is divided by a partition. On looking at an object through one of the compartments, a neighbouring object can be seen through the other; and by turning the tube upon itself, the partition may be made to coincide with the line of separation of the two objects. Close to the eye the instrument carries a movable graduated circle. If, continuing to regard the two objects, you turn this circle, you will remark that one becomes more distinct, while the other darkens. Soon the darker object becomes extremely black, while the other attains its maximum brilliancy. The graduation of the circle is so arranged as to show the difference in brilliancy of the two objects by the number of divisions which this circle has to be turned from the zero (found as above) until the objects appear in the field of view with an equal degree of brilliancy. To understand this better, conceive the shadow of a house cast on a white wall. Let us direct the telescope on the boundary line of the shadow; we see in one compartment the brilliant surface, and in the other the shadow; let us now turn the circle until the two parts acquire the same brilliancy, or until we see an equally illuminated surface. The divisions in the circle will then show that the mark which stood at zero at the commencement of our experiment has moved to 20, showing that the illuminated part of the wall is twenty times more brilliant than the shaded portion. Had the wall been yellow, blue, or any other colour, we should have found the same result. Instead of the wall and the shadow of the house, we might consider the ground and the shadow of a tree, a sunbeam and a shadow cast anywhere, the lines of separation of light and shade in a landscape, of a building and the sky, of blue sky and a cloud, etc.—in every case we would have obtained numbers expressing the relative brilliancy of objects contiguous to the field of vision, provided always that the photometer be suitably modified, not only according to the brilliancy, but the tints or colourings of the contiguous objects.

Let us now suppose an artist to have reproduced in a landscape a wall with a shadow, a piece of ground with the shadow of a tree, etc., and let us try to investigate the truth of his representation. The operations are precisely similar to those already described when examining the relations of the objects themselves.

M. Jamin states that after having submitted to the test of his photometer a great number of pictures, he has arrived at the unforeseen result, that in almost all, the proportional relations of the lights differ from those of nature. Always, or almost always, the shadows are not sufficiently deep; light and shade in pictures have also different colouring, so that the photometer, such as described, cannot, as in nature, render the apparent brilliancies of objects exactly equal. A twofold incorrectness is thus everywhere indicated, incorrect proportions of lights, false imitations of tints. Had these deviations from nature been trifling, painting might be admitted to be an approximate imitation of nature; but they are on the contrary very considerable. In the simple case of a body illuminated by the sun, and a shadow cast upon it, the relations found in summer, winter, different hours of the day, fine and bad weather, have been extremely varied. In general the minimum value of the relation of light and shadow is 10, its maximum value 20. But when sunbeams in pictures are examined, we find the above relations comprised between 2 and 4, so that the brilliancy of the sun-light is incomparably weaker in the pictures than in the true landscapes. It is difficult to conceive how the eye can tolerate such considerable inaccuracies. Still, all landscape painters do not deserve this reproach in the same degree; the modern school has made great progress towards exactness; every one may remark that their pictures have deeper shadows and brighter lights; some pictures of Decamps, for instance, present luminous effects comprised within the limits assigned by nature.

The discordance between nature and art in night pictures is not less remarkable. If in one of these pictures, usually lighted by a murky lamp, we compare the light of the lamp with the best illuminated parts, we shall find a relation comprised between 20 and 30. By placing in a room a lighted candle and a sheet of white paper, the ratio of the light of the candle to that reflected from the paper, will be found to be 1500; the candle flame is thus 1500 times as luminous as the paper, while in a picture it is made scarcely 30 times as luminous.

In the most celebrated interiors of Granet, the sky is 4 or 6 times brighter than the window-sashes of the rooms. To test this relation, M. Jamin selected a room with newly-painted sashes, which presented some similarity with those represented in Granet's pictures. By placing his photometer before the window, he found the sky 400 times brighter than the sashes. M. Jamin admits from trial the impossibility of imitating nature in this matter.

Let us now consider a complete landscape: in the foreground, masses of earth, trees, or buildings; in the middle distance, similar objects, seen through a stratum of air, which forms a kind of luminous veil, and increases their brilliancy; in the background, mountains, which blend themselves with the sky; the clouds, whose light far surpasses that of terrestrial objects; the sun, finally, whose dazzling splendour no eye can bear. Measured by the photometer, the luminous intensity of the clouds is several thousand, sometimes several million, times as great as a tree close to the observer. What can the painter do to imitate the infinite gradations in such a scale, when his brightest white has only a relation 80 times as great in the photometer as ivory-black? If he would adhere to the truth, he would be forced to recognize the existence of scenes which he should not attempt to paint; he should banish the clear sky from his pictures, and never try to represent brilliant clouds. But he can do better by consulting his imagination more than his eye, his interpretation of the reality rather than reality itself, and he will produce a picture possessing indeed only a fictitious reality, but still, charms of life and spirit that will render it acceptable and admired.

To recapitulate, painting is not, as too often supposed, an imitation of nature, but an admitted fiction whose productions do not possess physical reality. Moreover, were it attempted to give the art this character of reality which it wants, insurmountable material obstacles would arise. So that, of all schools of art, the least rational is the realist. Assuming to be accurate, the realists should be guided by photometry; but the photometer proves that they have not even approximated to nature in the relations of their lights. M. Jamin concludes by expressing his satisfaction that physical science should recall to painting its spiritual tendency, which seemed of late about to be forgotten.

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CHEMISTRY.

5.—*Electro-Chemistry.*

Professor Miller, of King's College, London, in presenting the first part of a "Report on the recent progress of Electro-Chemical Research", made some observations bearing upon the binary theory of salts, which are especially interesting and important, coming as they do from one who was hitherto one of the ablest supporters of the theory. According to Dr. Miller, the inquiries made of late years in the field of electro-chemistry were characterized rather by modifications of the laws previously admitted, than by any striking or important additions to the stock of scientific truth. Adverting to Faraday's observations of the exceptional conducting power of solid sulphide of silver and one or two other bodies, he stated that it had been shown by the researches of Beetz and Hittorf, that in these cases a true electrolytic decomposition occurred, a circumstance rendered possible by the somewhat viscous condition of the substances which exhibit this anomalous character. The true electrolytic nature of the decomposition was proved, firstly, by the rise of conducting power occasioned by rise of temperature (whereas in metals the effect of heat is exactly the reverse); and secondly, by the effects of polarization observed upon the electrodes between which such bodies are placed.

Allusion was next made to the insulation of metallic bodies by Bunsen, who had shown that in many instances, as in the decomposition of a solution of sesquichloride of chromium, the deposit upon its negative pole could be made to assume the reguline form, by reducing the surface of this plate to dimensions considerably smaller than the positive plate; a result probably owing in part to the secondary decomposition produced in the limited portion of liquid around the wire, whereby the sesquichloride was reduced to the protochloride of chromium, and subsequently the metal itself was deposited. This view was rendered probable by observing the effects obtained during the electrolysis of sesquichloride of iron, in which these successive stages could be distinctly traced. In cases in which, like the chloride of manganese, the compound was already in the form of protochloride, it was a matter of slight importance whether or not the negative electrode presented a smaller area than the positive electrode. Attention was called to the fact pointed out by Faraday, of the non-existence of more than one electrolyte in multiple series. In the case of the protochloride and of the bichloride of tin, the protochloride only is an electrolyte while in the anhydrous condition. The bichloride is not an electrolyte. Yet, when dissolved in water, itself also not an electrolyte, the solution conducts freely, and a similar result is observed in other analogous cases.

Referring to the decomposition of salts in solution, the bearings of electrolysis upon Davy's binary theory of the composition of salts, was briefly alluded to, and some of the difficulties attending the adoption of this theory in the case of the subsalts were mentioned; these facts, taken in connection with those already alluded to in the case of the bichloride of tin, leading the author rather to the view that a salt is to be regarded as a whole, susceptible of decomposition in various modes, and therefore admitting of representations under two or three different rational formulæ, each of which may, under particular circumstances, be advantageously made use of.

In the discussion which followed the statements of Dr. Miller, Dr. Apjohn observed that the advantages in certain cases, of reducing the dimensions of the anode had been well understood previous to the experiments of Bunsen. It was well known that when Wollaston decomposed water by a succession of electric sparks, he employed this expedient, no doubt because he had ascertained that it facilitated the electrolytic action of the interrupted current on the water.

6.—*On Proto-Sulphide of Carbon.* By M. E. BAUDRIMONT.

The proto-sulphide of carbon, CS, may be obtained by any of the following reactions: 1. In decomposing the vapour of the bisulphide of carbon, CS_2, by spongy platinum or pumice stone heated to redness; under those circumstances CS_2 is decomposed into CS and sulphur, which deposits on the sponge and obstructs its further action; 2. it is obtained during the preparation of bisulphide of carbon, and simultaneously with it; 3. by the decomposition of the vapours of CS_2 at a red heat, in contact with pure lampblack, wood charcoal, and especially animal black in fragments; 4. by the decomposition at a red heat of the vapours of CS_2 by hydrogen; 5. by the calcination of sulphide of antimony with excess of carbon; 6. by the reaction, at a red heat, of oxide of carbon on sulphide of hydrogen $CO+HS=HO+CS$; 7. by the reaction of sulphurous acid on olefiant gas at a red heat; 8. by the reaction of olefiant gas on chloride of sulphur at a red heat; 9. by the decomposition of sulphocyanogen by heat, etc.

The first process gives the gas sufficiently pure; the other methods give it mixed with sulphide of hydrogen and oxide of carbon. It may be purified by passing it rapidly through a solution of acetate of lead and protochloride of copper dissolved in hydrochloric acid, then drying it, and receiving it over mercury. It is a colourless gas, having an odour which reminds one of the common bisulphide of carbon, but not disagreeable, and strongly etherial. It burns with a beautiful blue flame, producing carbonic acid, sulphurous acid, and a little sulphur. Its density is a little greater than that of carbonic acid. It is not liquefied by the cold produced by a mixture of ice and salt. Water dissolves about its own volume of the gas, but it soon decomposes it into sulphide of hydrogen and into oxide of carbon $HO+CS=CO+HS$. It is scarcely more soluble in alcohol or ether. It is not absorbed by a solution of protochloride of copper. A solution of acetate of lead is not immediately blackened by it, but is after several hours' contact with it, and in the course of several days the gas is completely decomposed, oxide of carbon and sulphide of lead being formed. It is rapidly decomposed in contact with alcaline solutions. With lime-water, for example, the reaction gives sulphide of calcium and an equal volume of oxide of carbon, $CaO+CS=CaS+CO$. No carbonate of lime is produced in this reaction. At a red heat it is slightly decomposed: 1. by spongy platinum; 2. by the vapour of water into HS and CO; 3. more easily by hydrogen into HS and carburetted hydrogen; 4. by copper into sulphide of copper and carbon (graphitoïdal); 5. lastly, mixed with an equal volume of chlorine, a partial condensation takes place, the products formed being the subject of present research by the author.

On analysis made with oxygen in the eudiometer, it yielded equal volumes of carbonic and sulphurous acids, from which the formula CS is deduced. Its composition is, however, perfectly established also by its reaction with lime water, mentioned above. This is also corroborated by the determination of the quantities of carbon and sulphide of copper obtained when the gas is made to act upon that metal. The author promises a complete study of this body, which, he says, several chemists attempted to obtain, but heretofore without success, probably in consequence of water and alkaline solutions transforming it into oxide of carbon and sulphide of hydrogen. M. Persoz has, however, since drawn attention to a passage in his work, *Introduction à l'Etude de la Chimie Moléculaire* (Strasburg, 1837–38, page 117), in which he distinctly points out the fact of the formation of the compound CS during the preparation of bisulphide of carbon, especially if the vapour of sulphur be not rapidly and abundantly produced. He did not, however, examine its properties very minutely.—*Comptes rendus*, *t.* xliv. (11th of May, 1857), *p.* 1000.

7.—*On Caproic Acid.* By M. A. Wurtz.

M. Wurtz has made the very interesting observation, that the caproic acid obtained by Frankland and Kolbe by the action of potash upon cyanide of amyle, exerts a right-handed rotatory power, while it is probable that the same acid, obtained from cocoa-nut oil, has not any such power.—*Annal. de Chim. et de Phys.*, *t.* li. (November, 1851), *p.* 358.

8.—*Researches on the Phosphorus Bases.* By A. W. Hofmann and A. Cahours.

About ten years ago M. Paul Thenard pointed out, in a note on the action of chloride of methyl upon phosphide of calcium,[5] the existence of a series of bodies, which may be viewed as phosphoretted hydrogens, whose hydrogen has been replaced by an equivalent quantity of methyl. The discovery of methylamine, ethylamine, and the other compound ammonias, having given a new and peculiar interest to the subject, the authors took up the unfinished labour of M. Thenard, with a view of completing it, by a careful study of the bodies which he discovered, and by an extension of their number.

Instead of following the method of preparation proposed by M. Thenard, they found that they could procure such compounds more readily by the action of terchloride of phosphorus on zinc-methyl, zinc-ethyl, etc. The bases Me_3P and E_3P, which the authors propose to call respectively, *trimethylphosphine* and *triethylphosphine*, remain united with chloride of zinc, and may be liberated by a simple dilution with an alkali. They are obtained in this way as volatile oils of a peculiar and strongly marked odour, and possessing distinct basic properties.

The following is a list of the compounds which they have studied, and the details respecting the preparation, properties, and analyses of which, form the subject of a lengthened memoir presented to the Royal Society:—

Methyl Series.

Trimethylphosphine,	Me_3P
Platinochloride of trimethylphosphine,	Me_3P, HCl, $PtCl_2$
Binoxide of trimethylphosphine,	Me_3PO_2
Bisulphide of ditto,	Me_3PS_2
Biselenide of ditto,	Me_3PSe_2
Iodide of phosphomethylium,	Me_4PI
Platinochloride of ditto,	Me_4PCl, $PtCl_2$
Aurochloride of ditto,	Me_4PCl, $AuCl_3$
Iodide of phosph' ethyltrimethylium,	(Me_3E) PI
Platinochloride of ditto,	(Me_3E) PCl, $PtCl_2$
Iodide of phosph' amyltrimethylium,	(Me_3Ayl) PI
Platinochloride of ditto,	(Me_3Ayl) PCl, PCl_2

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[5] Comptes rendus, t. xxi. p. 144, and t. xxv. p. 892

Ethyl Series.

Triethylphosphine,	E_3P
Platinochloride of triethylphosphine,	$E_3P, HCl, PtCl_2$
Binoxide of ditto,	E_3PO_2
Bisulphide of ditto,	E_3PS_2
Biselenide of ditto,	E_3PSe_2
Iodide of phosphethylium,	E_4PI
Platinochloride of ditto,	$E_4PCl, PtCl_2$
Aurochloride of ditto,	$E_4PCl, AuCl_3$
Iodide of phosphomethyltriethylium,	$(MeE_3)\ PI$
Platinochloride of ditto,	$(MeE_3)\ PCl, PtCl_2$
Iodide of phosph' amyltriethylium,	$(AylE_3)PI$
Platinochloride of ditto,	$(AylE_3)\ PCl, PtCl_2$

The compounds named in the preceding table exhibit an almost perfect parallelism with the corresponding terms of the analogous nitrogen, arsenic, and antimony series; we have similar formulæ, similar modes of combination, similar decompositions. This analogy is particularly manifest in the compounds belonging to the *ammonium-type.* In these remarkable bodies, nitrogen, phosphorus, arsenic, and antimony, appear to play absolutely the same part. The oxides of these compound metals exhibit almost perfect identity of properties, to such a degree, that a mere study of their reactions would never indicate the presence of elements so dissimilar as nitrogen, phosphorus, arsenic, and antimony; while their alkaline power is so great that they might be confounded with potash and soda. The derivatives of nitrogen are only distinguished from the corresponding members of the phosphorus, arsenic, and antimony series, by the behaviour of the hydrated oxides under the influence of heat.

The compounds formed on the *ammonia-type* exhibit, on the other hand, a gradual increase in intensity of the electro-positive character, as we proceed from the nitrogen to the antimony series. Thus, trimethylamine and triethylamine are not capable of uniting with oxygen, chlorine, bromine, and iodine; while the corresponding members of the phosphorus, arsenic, and antimony series possess this power in a high degree.

Triethylamine unites with the acids producing compounds of the ammonium-type, and containing

$$E_3N,\ HCl$$
$$E_3N,\ HSO_4$$
$$E_3N,\ HNO_6.$$

Chemists have not yet succeeded in preparing the corresponding compounds in the arsenic and antimony series. Triethylarsine and triethylstibine only combine directly with oxygen, chlorine, sulphur, etc., producing saline bodies, which have the composition respectively of—

$$\begin{array}{ll} EAsO_2 & E_3SbO_2 \\ E_3AsCl_2 & E_3SbCl_2 \\ E_3AsS & E_3SbS_2 \end{array}$$

The two classes are, however, represented in the phosphorus series. Triethylphosphine not only forms compounds analogous to the salts of triethylamine, but also the terms corresponding to the binoxides of triethylarsine and triethylstibine. Thus:—

Corresponding	
to salts of Triethylamine	*to binoxides of Triethylarsine, etc.*
E_3P, HCl	E_3PO_2
E_3P, HSO_4	E_3PCl_2
E_3P, HNO_6	E_3PS_2

The phosphorus compounds accordingly hold a position intermediate between the nitrogen compounds, on the one hand, and the arsenic and antimony series on the other; but exhibiting a tendency rather towards the latter than towards the former. Considering the close analogies which phosphorus and arsenic present in other directions, this tendency cannot surprise us. Besides the circumstance that the acids of phosphorus and arsenic are polybasic (the acids of antimony have not been yet sufficiently investigated), while those of nitrogen are monobasic, the remarkable connection which subsists between the combining numbers of phosphorus, arsenic, and antimony, may be mentioned. If we compare those numbers we will find that the difference between the equivalents of phosphorus and arsenic is virtually the same as that between those of arsenic and antimony:—

Phosphorus, . . .	31	difference 44
Arsenic, . . .	75	
Antimony, . . .	120	difference 45

whilst the equivalent of nitrogen stands altogether apart from the rest.[6]

The same relative position of the elements nitrogen, phosphorus, arsenic, and antimony, may also be traced in their hydrides, H_3N, H_3P, H_3As, HSb. Ammonia is a powerful alkali; phosphoretted hydrogen unites only with hydrobromic and hydriodic acids, whilst in arseniетted and antimonietted hydrogen the power of combining with acids has altogether disappeared. In these hydrogen compounds the gradation of pro-

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[6] The authors do not appear to have noticed the very singular circumstance that the sum of the equivalents of nitrogen, phosphorus, and arsenic, is equal to the equivalent of antimony:—

Nitrogen, ...	14
Phosphorus, ...	31
Arsenic, ...	75
Equivalent of antimony =	120

The equivalent of nitrogen cannot, therefore, be said to stand apart. Indeed the difference (44 to 45) between the equivalents of phosphorus and arsenic on the one hand, and between arsenic and antimony on the other, noticed by the authors, is nearly equal in the former case, and exactly equal in the latter, to the sum of the equivalents of nitrogen and phosphorus. We may also point out another curious relation between the equivalents of those bodies, which is this: If we add the equivalents of phosphorus and antimony, the sum will be 151; if this be divided by 2, the product will be 75.5, or virtually the equivalent of arsenic.—W. K. S.

perties is, indeed, even more marked than in their trimethylated and triethylated derivatives. On comparing the terminal points of the series, ammonia and antimonietted hydrogen, we cannot fail to be struck by the dissimilarity of properties, which at the first glance appears to limit the analogy of the two compounds to a mere parallelism of composition.

In the methylated and ethylated derivatives of these compounds, the intensity of the chemical tendencies in general is so much raised, that the gradation is no longer perceptible to the same extent.—*Proceedings of the Royal Society*, vol. viii., No. 27.

MINERALOGY AND GEOLOGY.

9.—*Researches on the hygroscopic properties of the minerals of the family of the zeolites.* By M. DAMOUR.

The author, who has already on various occasions pointed out the property which certain minerals possess of losing and again readily taking up the water which enters into their composition, when they are successively submitted to the action of a perfectly dry atmosphere and of a more or less moist one, has made some interesting experiments, with a view of determining within what limits this property is possessed by the zeolites. The following is a summary of his results: 1. the zeolites, with a single exception (analcime), possess the property of losing considerable quantities, and sometimes the whole, of their water of combination, either when placed in a perfectly dry atmosphere, or when exposed to temperatures comprised between +40° C. and incipient redness; 2. zeolites which have been subjected to partial deshydratation, can recombine with the whole of the water which they have lost, by simple exposure to the air; 3. the temperature at which the water is disengaged, without altering the power of the mineral to take it up again, varies with the species of mineral; 4. the facility with which the deshydratation is effected, is usually in direct ratio to the number of equivalents of water contained in the mineral.

These results appear to the author to confirm the opinion that the zeolites, although usually found in crevices, cavities, or veins of certain rocks considered to be of volcanic origin, have been formed by aqueous dissolution, and not, like lavas, by igneous fusion. The author proposes to examine whether the deshydratation of minerals takes place in constant proportions, and corresponding to determinate temperatures.—*Comptes rendus, t.* xliv., *No.* 19, *p.* 975.

10.—*On the Gases evolved by the volcanic vents of Southern Italy.* By MM. Charles Sainte-Claire Deville and Felix Leblanc.

Any one acquainted with volcanic regions can easily imagine the difficulties which beset the experimenter in collecting the gaseous emanations which issue from vents. The high temperature of the localities where these vents occur, the suffocating odour of the gases evolved, the disposition of the ground, which renders their collection not only difficult, but often dangerous, and, lastly, the atmospheric conditions under which the greater part of the volcanic orifices are placed, are all so many obstacles to be overcome. The authors, by means of very ingenious apparatus, specially invented for the purpose, succeeded however in overcoming every difficulty; and accordingly, M. C. Deville visited, between the end of May and the commencement of August, 1856, the principal centres of emanations of Vesuvius, the Phlegræan Fields, Etna, Sicily, and the Æolian or Lipari Islands, and collected the gases. These he examined on the spot by means of a small portable laboratory; but, in addition, sixty-six tubes, first exhausted of air, were filled at these various localities, and sealed up by the blowpipe, and brought safely to Paris, where they were examined by the authors conjointly. The apparatus employed in the analysis was that of M. Doyère: the results were also controlled by comparative experiments made by the eudiometer of M. Regnault.

The chief results obtained by the authors may be summarized as follows:—

1. Atmospheric air plays a considerable part in the majority of volcanic emanations, sometimes even preponderating; but this air is almost always impoverished in oxygen, to an extent which, in some of the experiments, reached more than 3 per cent. So that the cone of Vesuvius, for example, may be compared to a kind of downflow chimney, in which certain gases are burned, owing to the high interior temperature, and at the expense of the oxygen of the air which flows in.

2. The higher crater of Vesuvius disengages carbonic acid; but this disengagement takes place through orifices quite distinct from those which evolve hydrochloric and sulphurous acids, and which play a totally different part in the distribution of volcanic forces. This circumstance establishes an analogy hitherto unobserved between certain of the higher fumoroles of Vesuvius, and the emanations of carbonic acid from the volcanoes of New Granada, long since noticed by M. Boussingault.

3. The nature of the gaseous elements escaping by the same orifice is subject to incessant variations. At the grand solfatara of Puzzuoli, the gas, which is expelled at the same time with the vapours of water under strong pressure and a considerable noise, and which deposits chloride of ammonium and sulphide of arsenic, was collected at two different epochs—the 10th of June and 30th of July, 1856, two specimens being collected on each occasion. The following table contains the results of the analyses of these specimens:—

	10th of June.		30th of July.	
	No. 1.	No. 2.	No. 1.	No. 2.
Sulphurous acid	6.8	6.4	24.7	0·0
Carbonic acid	0.7	0.0	0.0	5·7
Oxygen	92.5	19.4	14.5	18·4
Nitrogen		74.2	60.8	75·9
	100.0	100.0	100.0	100.0

From this it will be observed that carbonic and sulphurous acids substitute themselves, the one for the other, and even appear to mutually exclude each other. It may be well to observe that the authors found that the emanations did not contain any combustible gas.

On a previous occasion, M. Ch. Deville[6] observed, at a very short distance from the same place, at the little solfatara, variations of the same kind; not, however, between sulphurous and carbonic acids, but between the latter gas and sulphide of hydrogen—that is, in emanations corresponding to a weaker volcanic intensity.

4. The air at the summit of Vesuvius, and in the neighbourhood of the fumoroles, had the normal proportion of nitrogen and oxygen, and contained no foreign gas. But the air collected on the 30th July, on the shores of Lake Agnano, where, as is well known, carbonic acid is evolved in notable quantities, indicated the presence of that gas in a proportion sensibly higher than that found in normal air, while the oxygen and nitrogen maintained their usual relative proportions. M. Lewy had already observed that the air collected under certain circumstances in New Granada, contained much more carbonic acid than is usually found in the atmosphere.

5. From the analyses of the fumoroles collected on the lava of Vesuvius of 1855, it would appear that the anhydrous and non-acid ones contain a mixture of oxygen and nitrogen in proportions which are sensibly those of normal air, whilst the fumoroles which contain traces of the vapour of water, hydrochloric acid, or sulphurous acid, contain less than the normal quantity of oxygen. The gas of the lava of Vesuvius of 1820, analyzed by Sir H. Davy, and that of the lava of Hecla of 1845, analyzed by Bunsen, appear to be referable to the last category of fumoroles. We might naturally conclude from the preceding observations, that whenever fumoroles containing both hydrochloric and sulphurous acids, disengage themselves not only from lava, but from a volcanic crater or a fissure, similar alterations may be observed in the elements of the air. The following table of the composition of gases corroborates this opinion. The hydrochloric acid and vapour of water are deducted:—

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[6] "Dixième Lettre à M. Elie de Beaumont".—*Comptes rendus, t.* xliii., *p.* 747.

	Vesuvius.			Vulcano.	
	I.	II.	III.	Fumoroles with Flame.[7]	Without Flame.
Carbonic acid	0.0	0·0	0.0	0.0	0.0
Sulphurous acid	2.6	2.4	0.3	39.1	69.6
Oxygen	18.7	19.7	17.6	5.8	5.5
Nitrogen	78.7	77.9	82.1	55.1	24.9
	100.0	100.0	100.0	100.0	100.0
Relative proportion of oxygen to nitrogen, the sum of the two gases being taken as 100	19.3	20.2	17·6	9.6	18.8

6. The gas of the remarkable fumoroles which escape from the crater of Vulcano, with or without flame, and which deposits boracic acid, sulphur, chloride and iodide of ammonium, and sulpho-selenide of arsenic, traces of phosphorus compounds, etc., is composed of sulphurous acid, and of air poor in oxygen, and accompanied by the vapour of water. Carbonic acid is never present in those fumoroles.

7. The gases of fumoroles characterized by the presence of sulphide of hydrogen and carbonic acid, whether collected at the solfatara of Puzzuoli, the Lake of Agnano, or at Vulcano, and whatever may have been the quantity of sulphide of hydrogen originally present in them, have never yielded the slightest traces of that body in the analyses made in the laboratory. The authors explained this disappearance of the sulphide of hydrogen, by the reaction upon the oxygen of the moist air which accompanied it. Accordingly, the relation of the oxygen to the nitrogen was found to have diminished in some analyses, and to have become, for example, 11 to 89. The authors having found in several specimens considerable proportions of sulphurous acid, a gas notoriously incompatible with moist sulphide of hydrogen, have considered that this anomaly might be explained by supposing that at the very moment at which the gas was collected, reactions might have been produced analogous to those realised by M. Piria in his ingenious experiments relative to fumoroles.

Gas originally containing sulphide of hydrogen never afforded free hydrogen, a circumstance already noticed by Bunsen in the gas of the fumoroles of Hecla.

8. Even in the gases very rich in carbonic acid, like those of the Grotto del Cane, the ammoniacal Grotto of Agnano, and the acid spring of Paterno in Sicily, etc. (gases not containing any oxidizable compound), the ratios of the oxygen to the nitrogen are not those of normal air. For example, at Paterno the oxygen was to the azote : : 14.3 : 85.7.

9. A considerable number of emanations consist mainly of carbonic

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[7] The results of two analyses of fumoroles with flame from Vulcano are given in the original, but the second is manifestly incorrectly printed, and we have accordingly omitted it from the table in the text.

acid, or of carburetted hydrogen, or of a mixture of both. If the whole of the gaseous emanations in which the carbon predominates, be grouped together, we may get a series in which the extremes are formed, the one by carbonic acid, and the other by pure carburetted hydrogen, the intermediate terms indicating gradually increasing or diminishing proportions of the one or the other, as we go to one or other extreme. The following table exhibits such a series:

	Macaluba de Girgenti.	Salinelle de San-Biagio.	Salinelle de Paterno.	Lago di Naftia.	Acid Spring of Paterno.
Carbonic acid	1.15	67.00	90.07	94.70	93.23
Oxygen	1.70	0.51	1.00	1.10	0.97
Nitrogen	6.75	32.49	3.03	3.52	5.80
Carburetted hydrogen	90.40		5.00	0.68	0.00
	100.00	100.00	100.00	100.00	100.00

10. In the gas of the spring of Santa Venerina, on the flanks of Etna, we have commingled the two compounds of hydrogen whose oxidation has furnished the sulphurous acid, the vapour of sulphur, water and carbonic acid of the solfataras. This gas contains:

Sulphide of hydrogen	0.2
Carbonic acid	4.2
Oxygen	0.0
Nitrogen	12.1
Carburetted hydrogen	83.5
	100.0

This and the preceding analyses confirm the deductions suggested more particularly by the conditions under which the gases are evolved.

11. Finally, the authors have been led, by the analyses made at Paris and their subsequent discussion, to consider an active volcano, such as Vesuvius or Etna, as a centre whither emanations representing the products of the combustion of different combustible gases converge according to a certain number of planes geologically determined. In proportion as we go from this centre of activity, following one of the planes of eruption, we find at a given moment in the products evolved, the indication of a combustion less and less energetic. In a word, in taking into account time and space, the nature of the emanations given off from the same point vary with the time which has elapsed since the commencement of the eruptions, while at any given moment the nature of the fumoroles at different points varies with the distance from the eruptive centre.—*Comptes rendus, t.* xliv. (*April*, 1857), *p.* 769; *and t.* xlv. (*September*, 21st, 1857), *p.* 398.

COMPARATIVE ANATOMY, PHYSIOLOGY, ETC.

11.—*Researches on the nature of the Crystalline Humour in the different classes of Animals.* By MM. A. VALENCIENNES and FREMY.

The crystalline lens of the eye in animals is composed of three parts: the fibres, the cortical layers, and the nucleus. Hitherto the comparative study of these parts has been but little attended to. The authors have, however, recently investigated the case, and established a number of curious facts, interesting alike to the physicist and physiologist. They have shown, for example, that there is a very remarkable analogy between the crystalline lens and an achromatic one.

It is admitted by all anatomists that the substance of the nucleus is denser than that of the cortical layers: Brewster and Gordon have fully demonstrated this increase of density from the circumference to the centre. Hitherto, however, no chemical differences had been discovered between the different layers of the same crystalline lens. The authors accordingly submitted the lenses of different mammalia, such as the ox, the sheep, the horse, etc., to slow desiccation; all those examined behaved alike, that is, the cortical layers readily exfoliated, whilst the nucleus remained more or less compact. In examining the chemical composition of the different lenses, equal quantities of substance were always used, so as to avoid the errors resulting from operating on unusually concentrated albuminous solutions.

The cortical layers consisted of a noncoagulable albumen, apparently identical with that found by the authors in eggs, and which they propose to call metalbumen, in order to distinguish it from coagulable albumen. It has the following properties:—It dissolves in a large quantity of water; the solution is not troubled by boiling, but coagulated when neutral salts, such as chloride of sodium, etc., or acids, are added to the boiling solution. If it be concentrated at a very low temperature, so as to reduce it to a kind of syrup, resembling the gummy-looking mass of the lens itself, it may be coagulated by boiling, a circumstance which accounts for the coagulation which takes place when the lens itself is submitted to the action of boiling water. It dissolves in concentrated hydrochloric acid, but does not become blue under the influence of the oxygen of the air, as common albumen does. It leaves, on incineration, an ash not exceeding one per cent., and not containing alkaline chlorides. It is very similar to albumen, is precipitated by all the re-agents which throw down the latter, and does not differ much in composition from it.

In äerial animals, the nucleus of the crystalline lens consists of albumen, having the following properties:—it is soluble in water, coagulable by heat, and behaves in all its chemical reactions like the albumen of egg; it leaves more ash than metalbumen, and the ash contains a notable quantity of chloride of sodium; it dissolves in concentrated hydrochloric acid, but does not become blue by the action of air. Its composition may be considered the same as that of albumen of egg. The albumen is not always found in the centre pure and free from metalbumen; thus it was found in the lens in man, mingled with metalbumen in the cortical layers. When a liquor holding the two in solution is boiled, it simply becomes opaline, and gelatinizes if properly concentrated. The ostrich affords an example of the mixture of both in the nucleus. The proportion of albuminous substances contained in the lens varies with the species of animal, and appears to always increase with age.

It is well known that when albumen is treated with alcohol, it coagulates and becomes opaque. An egg preserved during some time in alcohol, hardens, as if it had been subjected to heat, and its albumen entirely loses its transparency. Its action upon the crystalline lens is different. The cortical layers, composed usually of metalbumen, are rendered opaque when kept in alcohol, while the nucleus sometimes assumes the aspect and semi-transparency of horn. This circumstance, which confirms the difference in chemical composition just established between the cortical layers and nucleus, is of great importance in comparative anatomy and zoology. Owing to this difference of action, the two parts can be distinguished; in some cases, however, the separation is not very sharply indicated, the nucleus remaining opaque, and being only separated from the cortical matter by layers of a gray substance. The authors think that in such cases the albumen and metalbumen are intimately mingled. These results were obtained principally by the examination of the lenses of the following species of mammalia, birds, and reptiles, which had been preserved in spirits for more than thirty years, having been obtained from the museum of the Garden of Plants, and generally put up by Cuvier: *Simia inuus*, *Mustella vulgaris* (Linn.); *Falco fulvus* (Linn.); *Falco ossifagus* (Linn.); *Strix virginiana; Strix aluco; Testudo imbricata* (Linn.); *Chelonia marmorata.*

In some lenses, as in those of the otter, faint outlines of the trisection of the lens in the direction of the fibres, could still be detected. In other animals, the nucleus, which would have become opaque in boiling water, assumes an amber colour more or less deep from the prolonged action of alcohol, and preserves its transparency. In this case, the cortical layers, composed chiefly of metalbumen, and which the action of the alcohol has rendered opaque, detach themselves very sharply from the nucleus, and thus enable many interesting observations to be made on their relative thickness. In the first place, the cortical layers are not equally thick on the two meniscuses of the lens, and great differences may sometimes be observed in the structure of the lens in animals very closely related, such as the horse and the ass. From sections made along the axis of vision, it would appear that the difference in degree between the anterior and posterior curvatures, depends principally on the relative thickness of the cortical layers on both faces; thus, in the ass the thickness on both curves is nearly the same, while in the horse it is greater on the anterior than on the posterior face. These differences are specific, and do not depend on accidental causes acting at the moment of the commencement of the action of the alcohol upon the albuminous parts of the lens. The most singularly constructed lens observed by the authors was that of an Indian elephant: the opaque layers of metalbumen were accumulated on the front of the lens, and only formed a simple membrane on the back; in this way the posterior curvature was very great, while the anterior face was flattened. This disposition was not observed in any other mamalian animal; it would consequently be interesting to determine whether such a disposition, observed in only one case, occurs in all the individuals of the same species.

From the numerous studies of the lenses of the mammalia made by the authors, it results that the segmentation of the lens varies with the species. In the quadrumania and in several carnivora of the genus Felis, and also in the dog, they found on the anterior face three segments, as in man. In the horse, the otter, the pole-cat, the beaver, the gazelle, the deer, the goat, there are four segments; in the ox there are only three segments; while the number rises to five in the chamois, and even to eight in the gigantic kangaroo. In the lens of the owl three rather indistinct segments were detected.

On examining the lenses, preserved with their capsules in alcohol, it was observed that the capsule is always thin; a lens of the common vulture, however, presented a consistent and very thick capsule. Among the lenses of mammalian animals examined, that of the dromedary was the largest; its diameter was $0^{m},021$, that of the nucleus being $0^{m},017$. The lens of the lion is also remarkable for its size, the diameter of one being $0^{m},018$; the two meniscuses presented the same convexity.

The lenses of birds coagulated by alcohol have not the same aspect as those of mammalian animals; the concentric layers which surround the nucleus are distinguished by a difference of coloration.

Fibres of the lens. The existence of a fibrous substance in the crystalline lens cannot be doubted. It is evidently this matter which retains the albuminous liquid, whose properties have been just stated, in its lenticular form. Kölliker has established that the fibres of the lens are hollow tubes, which contain the albuminous liquor. This fibrous substance is insoluble in water; it is transparent, and becomes opaque when submitted to the action of that liquid; it retains its transparency in contact with strongly albuminous liquids like that of the lens itself: the opacity which the lens assumes when exposed to moist air, is caused by the action of the moisture upon the fibrous matter. The fibres do not consist of fibrine, because they exert no action upon oxygenated water; they are insoluble in ordinary acids, but dissolve rapidly in acetic acid, even when very weak—a characteristic property first pointed out by Kölliker; this solubility cannot be compared to the swelling up of fibrine treated with acetic acid. The fibres have the composition of albumenous substances, but the authors think that the fibrous matter should not be confounded with the latter. The proportion of fibrous substance varies with the consistence of the different lenses; thus in man, where the lens is softest of all, the amount of fibrous matter is almost imponderable; the harder lens of the ox contains somewhat more, while in those of the aquatic mammalia, the quantity augments in still larger proportion.

The crystalline lens in the aquatic mammalia. The authors' observations upon the lenses in this family of animals were made upon those of the seal and several of the cetaceæ. From the observations made on the lens of a seal which had died, it was found that, while its cortical layers consisted of metalbumen, and its nucleus of albumen, like those of aërial animals, its centre was more solid than in the latter; the albuminous liquor is pasty, and is retained by a great number of fibres; owing to this circumstance, when the nucleus is treated with water, a solution of albumen is obtained, which solidifies in consequence of the abundant deposit of fibrous substance, which immediately hydrates and becomes opaque. These fibres dissolve in acetic acid, but much more slowly than the preceding. Thus, the generic characters which separate the mammalia from the fish, exist also in the lens of the amphibious mammalia; but in the latter, the nucleus is nearly solid, and thus, while having the same composition as the mammalian animals, it approaches in some respects the solid lenses of fishes.

Crystalline lenses of fish. The lenses of fish differ completely in composition from those of the other vertebratæ. While the latter, as we have seen, are formed of albuminous liquors differently concentrated, and maintained in the form of a lens by a fibrous substance, the lenses of fish are characterized by a solid nucleus, formed of a substance insoluble in water, and to which the name phaconine, from φακός, a lens, has been given, The cortical layers are formed of albumen, which coagulates by heat, like that of eggs; the nucleus is phaconine, in the form of concentric layers, which are readily reducible to filaments. Phaconine is insoluble in water, alcohol, and ether, is perfectly transparent, and this property is not destroyed by the prolonged action of boiling water. If the filamentous membranes of the phaconine constituting the nucleus of the lens of a fresh fish, be detached before cooking, and be placed in contact with cold water, they become opaque, and swell up. Phaconine is almost insoluble in ordinary acids, and is not transformed into a gelatinous substance by their action; it dissolves slowly in acetic acid; alkalies dissolve it, but with difficulty; this substance, consequently, presents a certain analogy with that which forms the fibres in the lens of mammalian animals. The following table represents the composition of the metalbumen, albumen, and phaconine:—

	Metalbumen from the lens of an ox.	Albumen.	Phaconine.
Carbon,	52.8	51.89	52.11
Hydrogen,	7.3	6.75	7.69
Nitrogen,	16.0	15.46	16.53
Oxygen,	23.9	25.94	23.67
	100.0	100.04[8]	100.00

Phaconine may, consequently, be considered as isomeric with the other albuminous bodies which constitute the lenses of mammalian animals.

The authors were unable to determine the differences which, doubtless,

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[8] It is thus in the original.

exist between the two crystalline segments of the double eye of *anableps tetrophthalmus*, the singular disposition of which was the subject of an interesting memoir by M. de Lacepede.[9]

Lenses of the cephalopoda. The solidity of the nucleus formed of phaconine is not the exclusive characteristic of the lenses of fish, but rather of those animals who live exclusively in water. The lenses, for example, of cephalopoda have the same composition as those of fish. The cortical layers are albuminous; the nucleus is solid, and composed exclusively of phaconine. In thus proving an absolute identity between the lenses of fish and those of aquatic mollusca, the authors have established a very curious physiological fact, namely, that the composition of the crystalline lens depends upon the medium in which the animal is to live. In examining the lenses of cephalopoda an interesting fact was discovered, which had not been hitherto noticed by any anatomist, namely, that the lens is composed of two unequal and perfectly distinct segments. In the *Loligo pavo*, the larger segment is more concave than the other, and is always the posterior one. The upper meniscus is perfectly distinct from the posterior one; they may be separated by the slightest shock, and a section of the lens exposed. The cortical layers are formed of albumen coagulable by heat; the nucleus containing phaconine is disposed in concentric layers differently coloured. The authors are desirous of directing the attention of those physicists who occupy themselves with the determination of the direction which the luminous rays follow in traversing the humours of the eye, to this extraordinary structure of the eye, which is the same in all the cephalopoda.

A curious application of the author's researches may be mentioned; they discovered that the transparent bodies found in place of the eyes of some mummies, brought from a tumulus near Arica in Peru, were the lenses of cephalopoda.

They attempt to determine the nature of the eyes of the garden snail, slug, etc., and of those more singular ones which constitute the numerous occuliform and brilliant points which exist between the cilia and the tentaculæ of several acephalæ, such as *Pecten maximus* and *Pecten jacobæus*, etc. All these small eyes appeared to have a kind of small crystalline lens, which hardened on being boiled; but these corpuscles are so small, that they have reserved them for future investigation.

The whole of the results may be summarized as follows:—

1°. That the crystalline lens of a mammalian animal is formed of fibres, insoluble in water, and united at the centre by an albuminous substance, coagulating at about 65°, but becoming transparent and amber-like by the prolonged action of alcohol, and united exteriorly by an albuminous body non-coagulable by boiling under the conditions indicated, not becoming blue by the action of hydrochloric acid, and which has been called *metalbumen.*

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[9] The singular disposition of the eye of *anableps tetrophthalmus*, or *lobitis anableps*, as it was formerly called, to which the authors allude, is the division of the cornea and iris by transverse ligaments, and the existence of two pupils, giving the appearance of a double eye, while there is only one crystalline humour, one vitreous humour, and one retina. This extraordinary fish is found in the rivers of Guyana and Surinam. See Lacepede, *Mém. de l'Institut. National*, *t.* ii., *p.* 372.

2°. That these two substances, anatomically distinct, and constituting two different parts of the lens of a mammalian animal, should be distinguished by special names; the name *endophacine* is accordingly proposed for the central portion, and *exophacine* for the external layers.

3°. That the crystalline lens of birds, reptiles, and batracians, differs very little from those of the mammalia.

4°. That the lens of fish is likewise formed of two distinct parts; the one, cortical, or exophacine, is composed of metalbumen; and the other, or nucleus, is formed of an albumenoid substance, solid and insoluble in water, and called phaconine.

5°. That the fibres of the lens of the mammalia, united by albumen or by metalbumen to form the endophacine or exophacine of the lens, have considerable analogy with the phaconine of fish.

Morbid alteration of the crystalline lens. The authors have made some exceedingly interesting and important observations on the alterations which lenses undergo when they become opaque from the effects of disease, as, for instance, cataract. The observations were chiefly made on the lens of the horse, which, as is well known, is sometimes affected by this disease. They discovered that in this case the lens suffers a modification which resembles in a certain degree that which has been observed to take place when a lens is exposed to the action of alcohol or boiling water. The albumen and metalbumen which constitute the healthy lens of a horse, become, by the action of the disease, insoluble in water, and form slightly opaque membranes, which may be readily separated from one another. This modification is not due, as has been supposed, to phosphate of lime, which would modify the properties of the albumen; but, on submitting these membranes to analysis, it was found that they did not leave more ash than ordinary albumen.

[I made, on two or three occasions, some analyses of lenses affected with cataract, which corroborate in a most striking manner the views of MM. Valenciennes and Fremy upon that disease contained in the preceding memoir. The lens was carefully weighed, dried in a water bath, then in an oil bath heated to a temperature of 130°, weighed, then incinerated, and the ash weighed; in no case did I find that the per-centage of ash, and especially of phosphates, exceeded that of a lens quite free from disease. The condition in which I received the specimens was such as to preclude the possibility of my obtaining any accurate results as regards the per-centage of water; nevertheless, I may observe, without desiring to attach much importance to the circumstance, that the diseased lens appeared to always contain more water than healthy ones. It may be well to observe, however, that healthy lenses exhibit a variation in the per-centage of water, within certain limits. It would be interesting to discover whether the opacity of the lens in disease, is the result of increased hydratation.—W. K. Sullivan.]

ETHNOLOGY.

12.—*On the Inhabitants and Dialect of the Barony of Forth, in the County of Wexford. By* VERY REV. C. W. RUSSELL, D.D., *President of St. Patrick's College, Maynooth.*[10]

[Communicated by the Author.]

Among the minor curiosities of the ethnographical map, one of the most interesting is the occasional occurrence, in the centre of one of the great families of language, of some fragment of another and entirely distinct tongue, which is found to have maintained itself in complete isolation, in vocabulary, in structure, and inflexions, from that by which it has been, perhaps for centuries, surrounded. All the more prominent examples of this phenomenon—as that of the Basque cropping up in the midst of the Italo-Pelasgic group; of the Ossete in the centre of the Caucasian; and the Samoyede in that of the Tartaro-Mongol—have already been the subject of much learned speculation. I allude at present to certain less known and less striking, though, in some respects, hardly less instructive instances, in which the affinities of the intruder with the group amidst which it is found are closer and more appreciable. Such, for example, is that of the well known German dialect of the *Sette Communi* of Verona, and the *Tredici Communi* of Vicenza—descendants of the few stragglers of the Cimbrian expedition into Italy, who nearly two thousand years ago, escaped from the almost total extermination of their army under Marius; or the converse example of the Latin vocabulary and the Latin forms, which have been preserved in the Romani languages of Wallachia, since the days of the Latin colonies planted upon the Danube under the early Roman emperors.

The object of the present essay, however, is not to trace the history of these foreign anomalies, but to bring under the notice of the Section a domestic example of the same singular phenomenon, which, although well known in Ireland, has received but little attention elsewhere, and which, even in Ireland, has never been thoroughly discussed: I mean the peculiar dialect which, up to the last generation, continued to be commonly spoken in the baronies of Forth and Bargie, in the County of Wexford.

A paper on the subject of this dialect, accompanied by a metrical specimen and a short vocabulary, was printed by General Vallancey in the second volume of the *Transactions of the Royal Irish Academy*, and it is alluded to by several writers; but I am not aware that any regular attempt has been made to analyze its elements, or to investigate its character. Vallancey is content to represent it as the ordinary English of the period of the Invasion, preserved unaltered by the descendants of the original colony. But a more common, and in Ireland a more popular opinion, looks upon it as of Flemish origin, or at least, as exhibiting the Flemish element in a very high degree. I purpose, in the following observations, to submit for the consideration of the Section whatever lights upon the question appear to me to be derivable, first, from the history of the colony, and secondly, from the vocabulary and structural or grammatical analysis of the dialect itself.

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[10] Read at the Dublin Meeting of the British Association, August, 1857.

1. The origin of the colony presents no difficulty. All writers upon Irish history, local and general, agree in considering it as a settlement of the first adventurers, who, in 1169, accompanied the expedition of Strongbow, Fitzstephen, and Maurice Fitzgerald, to Ireland, and to some among whom lands were assigned in the district now known under the name of the baronies of Forth and Bargie. This little band consisted of one hundred and forty knights, and three hundred infantry. The latter, being followers of Strongbow and Fitzstephen, may be presumed to have been recruited in Glamorganshire and Pembrokeshire; and one of the main foundations of the hypothesis of the Flemish character of the language of their descendants is derived from this circumstance. The population of these counties was at that time a very mixed one, consisting not only of Welsh, but also of English, of Normans, and of other foreign adventurers. Among these were a large number of Flemings who had been settled in Wales for nearly half a century previous to the invasion. A terrific inburst of the sea in 1107, and again in 1113, had laid waste the seaboard of the Low Countries, and had driven a considerable body of Flemings for refuge to England, with which country, since the marriage of Matilda, daughter of Baldwin of Flanders, with the Conqueror, a close connection had been maintained. With the English peasantry, however, these foreigners were from the first so unpopular, that the king, Henry I., found it expedient to collect them all into one settlement around the present Haverfordwest, in Pembrokeshire, where they were joined by a subsequent immigration of their fellow-countrymen, who came over as military adventurers in the reign of Stephen I., in 1138.

These Flemish settlements had their centre in the south of Pembrokeshire and the south-west of Glamorganshire, in that peninsula west of Swansea Bay, still known as the Gower district; and that they engaged in considerable numbers in the invading expedition under Strongbow, is inferred from the number of seemingly Flemish names, such as Connick, Colfer, Godkin, Bolger, Fleming, Furlong, Waddick, Ram, Scurlock, Rossiter, Prendergast, Wadding, Codde, Lambert, Parle, and others, which are still to be found in different parts of the county of Wexford, but especially in these baronies of Forth and Bargie. On a closer examination, it is true, this evidence will be found in part illusory. Of the names on which it is founded, some, as Ram and Godkin, are certainly of a date far later than the Anglo-Irish invasion. Others, as Rossiter, Lambert, Prendergast, however Flemish in appearance, are unquestionably Norman or English. Mr. Herbert Hore, of Pole Hore, however, in a learned paper in the *Archæologia Cambrensis* (New Series, iii. 127), clearly proves the Flemish origin of many of the Wexford families. A roll of Wexford men, summoned for military service in 1345, cited by him, contains several unmistakably Flemish names. And on the whole it is impossible to doubt that the original settlement in the baronies of Forth and Bargie, contained a considerable infusion of that Flemish element which already existed in the population of Pembrokeshire and Glamorganshire. With the view of ascertaining the proportions of the two races at present, I addressed a sheet of printed queries to the clergy of the two baronies, but unfortunately the time was too short to permit any exact conclusions. Thus much, at least, is certain: that a large majority of the names is Norman or English, as Stafford, Devereux, Barry, Hore, Browne, Gifford, Lambert, Roche, Hay, Whitty, Mitton, etc., some of which are still popularly known by the hereditary character embodied in the rhyme :—

Stiffe Staffort,	Stiff Stafford.
Gai Gaffort,	Gay Gifford,
Dugged Lamport,	Dogged Lambert,
Leighen a-Chiese,	Laughing Cheevers.
Proud Derouze,	Proud Devereux.
Criss Colfere,	Cross Colfer.
Valse Vurlonge,	False Furlong.
Gentleman Broune,	Gentleman Browne.

II. But secondly, even were it certain that the Flemish element had preponderated in the population at the time of the original settlement, it may be doubted whether that circumstance could be regarded as conclusive in deciding how far the same element was actually introduced into the language of the colony. It would yet remain to be inquired whether the Flemings of Wales themselves at that period still retained their native language in its integrity. Now, it must be recollected, not only that the Flemings were not the only foreigners then settled in Wales, but also that the Welsh colony of Flemings was, by this time, at least in its second generation. We know, too, that even at the first settlement, Henry I. sent English colonists among them to teach them the English language; and so successful was this policy, that, as early as the time of Higden, it is said of their descendants that "dimissâ jam barbarie Saxonicé satis loquuntur"—(*Higden*, *Gale's Ed.*, p. 210). This Pembrokeshire colony, indeed, was so eminently English, that it was known under the name which Camden himself renders, "Anglia Transwallina"—"Little England beyond Wales". The most, therefore, that can certainly be presumed of the original language of the adventurers who settled in Forth and Bargie, is that the form of English which they introduced contained a certain portion of the Flemish element.

But, whatever was the precise character of the language of these colonists, authorities agree that their descendants preserve, with singular fidelity, not only this language, but also many peculiarities of manner, of social and domestic usage, and even of costume. The most notable of these were maintained in full observance down to the generation before the last, and are well remembered by many old persons still living in the baronies. In the seventeenth century they were almost universal.

In the Southwell MSS., now in the possession of Sir Thomas Phillips, of Middle Hall, Worcestershire, are a series of returns regarding the county of Wexford, written about 1680, and supplied to Sir William Petty, copies of which have been kindly communicated to me by Mr. Edmund Hore of Wexford, to whom I am indebted for much valuable information on the subject of the language. In the first of these returns, which is anonymous, we are told that "they preserve their first language (old Saxon English), and almost only understand the same, unless elsewhere educated"; that "they observe the same form of apparel their predecessors first used", which is, "according to the English mode, of very fine exquisitivelie dressed frieze, comlie, but not costlie"; that they "inviolablie profess and maintain the same faith and form of religion" (of their observances in which particular many most interesting details are described); and that "they seldom dispose of their children in marriage but unto natives, or such as will determine to reside in the barony". There is one of the customs mentioned by him which deserves a special notice. "In summer", says he, "they constantlie desist from all works about ten of the clock, soon after dine, reposing themselves and their ploughhorses until two of the clock, during which time all sorts of cattle are brought home from the field and kept enclosed". Another of the reports in the same MS., by Colonel Richards, an old Cromwellian officer, then governor of Wexford, goes still farther, and not only states that "about high noone men and women, children and servants, naturally cease from labour, and goes to rest for about one hour or two", but adds that "*the cattle doe soe too*—the geese and the ducks repaire into their master's yard, and the cocks and hens do goe to roost for that time, and exactly at the hour!" This usage of the siesta (though perhaps not quite to the extent described by the worthy colonel), has continued down to the generation now living. It is called in the local dialect "enteet", or more properly *nonteet* (noontide)—"the noontide rest".

There is another of the colonel's notices of the barony which will startle you no less. In describing the women of Forth, he assures us that "in one particular they excel all their sex in this kingdom, viz., they so revere and honour the male sex, man, beast, and bird, that, to instance one particular only, if the master of the house be from home, his sonne, if any, or, if none, then his chief servant present, though but a poor plough-driver or cow-boy, shall have the first mess of broath or cut of meat, before the mistress and her female guests, if she have any! This I know, but I have heard it affirmed, that if there be noe man or boy in the house, *they will give the first bit to a cock or a dog, or any male creature!*" Whether it be that the rights of women are now better understood by the fair ones of the barony, or that the tone of the other sex has been elevated since the colonel's day, I am happy, for the honour of modern Forthite gallantry, to add, that of this strange usage I have not been able to discover any present trace.

The same, indeed, might be said of most of the peculiar usages of the district. Fashion in this, as in other matters, has prevailed over traditionary feeling. The youths and maidens of the new generation have grown ashamed of the ways of their elders, and accommodated themselves in most things to the customs by which they are surrounded; and now almost the only characteristic by which the people of Forth and Bargie are distinguished from their neighbours throughout the county, is their superior industry, intelligence, and thrift.

The language has shared the same fate. Even in 1788, at the time when Vallancey collected the specimens of it which give interest to his paper, it was not without some difficulty that he discovered experts sufficiently intelligent for his purpose; and the vocabulary which he printed was chiefly supplied by an old gentlewoman named Browne, commonly known under the title of "The Madam". An old man named Dick Barry, of Ballyconnor, who lived to an exceeding old age, was probably the last genuine representative of the Forth-speaking peasantry. Hardly one is now to be found in the entire district who uses it as a familiar tongue; and very few, and these only among the oldest Forthers, can be said even to be familiar with the common words of the vocabulary. An address, written by Mr. Edmund Hore, was presented to Lord Mulgrave in 1836; but it must be regarded rather as a pleasant surprise for the good humoured curiosity of that popular nobleman, than a serious literary or political composition. Like Irish in what used to be the Irish-speaking districts, the Forth language has become unfashionable in Forth itself; and the young generation are unwilling even to acknowledge an acquaintance with it, much more to employ it as a medium of ordinary intercourse.

The idea of the Flemish origin of the dialect is comparatively modern. Grose (*Antiquities*, ii. 61) holds it, it is true, to "be a Teutonic tongue, introduced in the first age of Christianity, or perhaps earlier". But no one has ever seriously discussed so wild a theory. I have already alluded to the opinion of Vallancey, that the Forth dialect is nothing more than the English of the invaders. The anonymous report in the Southwell MSS., written in 1682, describes it as "old Saxon English". Colonel Richards pronounces it "the very language brought over by Fitzstephen", and adds that "whoever hath read old Chaucer will better understand it than an English or Irishman". A third contemporary report in the same MS. collection concurs in this view.

Stanihurst, however, with more exactness, while he agrees in regarding English as the substance of this dialect, adds, "that in our daies they have so acquainted themselves with the Irish as they have made a mingle-mangle or gallimaufrere of both the languages, and have in such medley or checkerwise so crabbedlie jumbled them together, as commonlie the inhabitants of the meaner sort speak neither good English nor good Irish". Of the samples of the vocabulary which he gives some are plainly Irish.

If we possessed any satisfactory specimens of the language, this controversy would present little difficulty. Had we some Forther "Tim Bobbin", or even some collection like those of the English provincial songs; had any of our native novelists, by introducing it into their dialogue, done for it what Conscience has done for his native Flemish, or Auerbach for the rude dialect of the Black Forest, it would be easy to determine its real character. But, unfortunately, hardly any relics of the language are now recoverable, although the old inhabitants declare that, in their early days, songs and ballads in the native dialect abounded in the baronies; in which also I am assured many of the old English ballads, as *Chevy Chase*, *Robin Hood*, etc., were quite common among the people. The Right Rev. Dr. Browne, Catholic Bishop of Kilmore, remembers to have heard, when a boy, a great variety of Forthite songs, said or sung by a blacksmith in his native parish. Mr. Edmund Hore once had met in a number of the *Wexford Chronicle*, of the year 1772, a considerable collection of metrical pieces; but, unluckily, the paper was inadvertently destroyed, and I have in vain appealed to every quarter which seemed to offer a hope of recovering this collection. A few scraps, which, it must be owned, have their full share of the *Fescennina licentia*, are all that I have been able to find. One friend had often heard in his youth a rustic song, commencing :—

Th'ar was a Waddeen in Bollymore,
Th'ar was a hunnert, lackin a score;
Y'ar welcome hartille, y'ar welcome joyes,
Y'ar welcome hartille every one.

The song proceeded to describe the company there assembled, but the only further fragment he remembers is a line about

Ee Vrieste o'paryshe on a long-tailed garrane.

There was another, which began—

A maide vrem a Bearlough,
Anure vrem ee Bake,
E'sholthet ownanoree,
Nich th' hia thoras o' Culpake.

One of these maids was bringing to market a *tick* (kid)—the other a basket of eggs; unluckily the kid, in some awkward gambol, jumped against the basket and broke the eggs; and the fun of the piece consisted in the scolding-match which ensued between the fair ones, and in which all the Billingsgate of the dialect is exhausted.

Sometimes the common English ballads contained a few words in the native dialect, generally in the nature of a hit at the Forthers. There is one about a mumming expedition, which, according to the old country fashion, a party of young men from Duncormac made into the parish of Kilmore, where, instead of receiving the hospitality which they expected, they were put off by the canny Kilmore men with regrets and apologies—

In rank and fine order we marched to Kilmore,
Our only intention being mass to procure,
But the hochanny set unto us did say,
"Fad didn'st thou cum t'ouz on zum other dey?—
Fad didn't thou cum t'ouz phen w'ad zum thin to yive?"—
But curse on the churls, 'tis at home we could live.

The only complete piece which I have been able to recover is that printed by Vallancey. I shall give a short account of it, together with the opening and concluding verses, as a sort of text for the observations on the structure of the dialect which it seems to suggest. The theme is of the simplest. An old yeoman, Walthere (Walter), who is described as "lournagh" and "hachee" ("low spirited" and "out of temper") with the world, in answer to the remonstrance of one of his neighbours, Jone (John), on his downcast and moody appearance, relates how a great match of the well-known rustic game of *commane* or *hurley*, in which two neighbouring parishes were pitted against each other, had been lost through an unfortunate miss on the part of his son, Tommeen. It begins by Jone's demanding—

"Fade teil thee zo lournagh", co Jone, "zo knaggee!
Th' weithest all curcagh, wafur, an cornee,
Lidge w'ous ana milagh, tis gai an louthee
Huck necher y'art scudden—fartoo zo hachee?"

Walthere replies—

"Well, gosp, c'hull be zeid; mot thee fartoo an fade;
Ha deight ouz var gabble tell ee zin go t'glade.
Ch'am a stouk, an a douel; wou'll leigh out ee-dey;
Th' valler w' speen here, th' lass i chourch hey".

"What ails you, so melancholy", quoth John, "so cross?
You seem all snappish, uneasy, and fretful;
Lie with us on the clover, 'tis fair and sheltered;
Come nearer, you're rubbing your back, why so ill-tempered?"

"Well, gossip, it shall be told; you ask what ails me, and for what,
You have put us in talk till the sun goes to set.
I'm a fool and a dunce; we'll idle out the day;
The more we spend here, the less in the churchyard".

I must refer to Vallancey for the narrative. Walthere proceeds to tell that the game was "jist ing our hone"—all but won by his party—had it not been that by ill-luck his son "Tommeen was ee pit t' drive in"—that is, placed as the player, to give the *barnaughblow*, the decisive stroke, which was finally to drive the ball through the enemy's goal. At first the odds had all been against Tommeen's party, but the scale turned, and they were on the point of complete success. The ball was almost at goal, and needed but a gentle stroke to drive it through, when, instead of a gentle "dap or a kewe", Tommeen, in his unlucky over-eagerness, "yate a risph"—drew a tremendous blow, and, striking his bat upon an anthill, (emothee knockane) shivered it in his hand. Losing the advantage by this unlucky indiscretion, he gave the adverse party an easy victory. Hence the mortification and chagrin of the narrator.

The concluding stanzas, which describe the rough but hearty consolation offered to Walthere by his listeners, are highly characteristic—

"Ha ha! be me coshes, th' ast ee paid it, co Jone;
Y'oure w' thee croaken, an ye me thee hone!
He et nouth fade t'zey ee'lean vetch ee man,
Twist thee an Tommeen, and ee emothee knaghane.
Come w'ous, gosp Learry, theezil, and Melchere;
Outh o'me hone ch'ull no part wi Walthere.—
Jowane got leigheen; she pleast am all'.—Howe?
Sh'ya ame zim to doone as w'be doone nowe:
Zo bless all oure vrendes, an God zpeed ee plowe".

"Hey ho! by my conscience you have paid it", quoth John.
"Give o'er your crossness, and give me your hand.
He that knows what to say, mischief fetch the man,
Betwixt you and Tommy, and the pismire hill.
Come with us, gossip Larry, yourself, and Miles;
Out of my hand I'll not part with Walter.—
Joan set them a laughing; she pleased them all thaw?
She gave them some to do as we're doing now: (drinking).
So bless all our friends, and God speed the plough".

Meagre as is this specimen of the language, it will at least enable us to form a general idea of its chief structural and grammatical peculiarities. It is hardly worth while to advert to the principles of pronunciation. Many of them are, in the main, those of all the archaic forms of English, at least from the period when English orthography became sufficiently settled to enable us to judge. The hard *g* and *c*, the broad sounds of the vowels, the peculiar powers of the diphthongs, are all very strongly marked in the Forth dialect; and there is a general tendency in it to lengthened and drawling accentuation, which cannot fail to be observed. Many of our modern monosyllables appear in Forth in the dissyllable form—"halluf", "calluf", "moweth" (half, calf, mouth), etc.; and in dissyllables the accent is almost invariably laid by the Forthers on the last syllable.

In the inflections of nouns, pronouns, and verbs, there are some things which call for more special observation. The most ordinary form of the definite article is *ee*, and when the modern article is used, the final vowel is commonly elided. Nouns in the possessive case invariably follow the modern inflection of *s*, instead of the Chaucerian *es* or *is;* and the old plural termination *en* is almost entirely unknown in Forth. The plural of nouns is commonly *es*, which termination, however, is always *a distinct syllable*, and converts a monosyllablic noun into a dissyllable in the plural; as "man, mann*es*". There are a few exceptions, such as, "keyen", kine, "pizzen", peas, "ein", eyes, etc., etc. But it is remarkable that some of the words in which these anomalies occur are also abnormal in modern English itself.

The personal pronouns, with the exception of "ich" (pronounced "itch"), "I", and the old Saxon "hi" (they), are almost the same as in modern English; but in prefixing them to the persons of the verb, as also in prefixing articles, prepositions, and similar particles, whether to nouns or verbs, the final vowel is always elided, even before a consonant. Thus the substantive verb is conjugated, "ch'am", "th'art", "he's" "she's", "w'ar", "th'ar"; so also "ch'ave", I have; "th'ast", thou hast; and in the infinitive, in prefixing the preposition "to", the same elision takes place, even before a consonant, as "t'drowe", to throw.

In the regular verb the terminations of the singular are the same as in the modern English verb; but the plural occasionally follows, in the second and third persons, the old Saxon or Frisian ending "eth";—a form which, for the second person, is familiar to the readers of Chaucer, as in the line,

"Riseth up, sir preest, and stondeth by me".

On the contrary, the old Chaucerian ending of the third person, "en" is unknown in the Forth dialect, as is also the "en" of the ancient infinitive.

The present participle ends in "en", or "een"; and the past retains the old "y" prefix, or "ee", often prefixed to the simple infinitive, as "ee-drowe", from "drowe", "to throw", and sometimes to the participle, as "ee deight". In some participles, however, this prefix is omitted, and some others follow a form almost of purely German character.

The vocabulary has hitherto been chiefly known from Vallancey's paper; but, through the kindness of Mr. Edmund Hore, I have received a very considerable supplement to that collection of words. However strange this vocabulary may appear to one unaccustomed to archaic English, it is impossible to doubt that in the main it is English. A large proportion of the words are perfectly identical with their modern counterparts; and others, as "vorreat", forehead; "bawcoon", bacon; "stuckeen", stocking; "maistreace", mistress, are but broad sounds of the modern English.

Still it is equally certain that many of the words are decidedly un-English. As it may fairly be presumed that the early settlers married in the country, the first mothers of the colony can hardly have failed to leave a trace of their native tongue in its language. Accordingly, notwithstanding Vallancey's assertion to the contrary, the dialect contains a considerable mixture of Irish words; as, "puckane", a goat; "garrane", a horse; "knockane", a hill, etc.

Whether, and how far the Flemish element may be traced in it is much less clear. From what I have already said, it is plain that Flemish must have some influence on the original language; but I am satisfied that this influence was less than has commonly been supposed. It is true that there are some words which at first sight have a very foreign look. Such, for example, are a large class of words beginning, in modern English, with *f* or *p*, but in the Forth dialect, as in the Flemish or Dutch, with *v;* as, vrom, vresh, vroste, voote, vrist, vour, etc. There is also a similar change of *s* into *z;* as, zin, zey, zill (amezil), zitch, etc.; but this seeming identity will appear less conclusive for the Flemish origin of the Forth dialect, when it is recollected that the very same peculiarities occur in almost the entire of the southern group of the provincial dialects of England;—the *z* in the Somerset or Dorset; the *v* in these dialects, and still more in those of Devon and Wilts. So, also, the coincidence of the forms of certain of the numerals in the Forth dialect with the Flemish, by which some persons have been struck, equally occurs in English dialects. Again, the seemingly peculiar Forth demonstrative "dicka", is exactly the Devonshire "thicka"; and I have little doubt that any adept in archaic or provincial English, would find it an easy task to trace the same analogy through the entire Forth vocabulary, with the sole exception of the Celtic portion, to which we have already alluded.

On the whole, therefore, I cannot hesitate to say that the notion of any decidedly Flemish affinity of the Forth dialect appears to me an illusion. Trying it by either or both of the two great rival tests adopted by the opposite schools of comparative philology, I can find no trace whatever of any peculiar Flemish characteristics, whether in its structural forms or in its vocabulary. The inflections of its nouns and verbs are entirely different from the Flemish: the vocabulary has hardly anything Flemish in it which may not be explained by the common descent of English and Flemish from one German stock; and much that appears Flemish at first sight in the Forth dialect, is equally found in other dialects of English, to which no one has ever dreamed of ascribing a Flemish origin.

If I could have hesitated in this conclusion at all, my doubt would have been removed by the judgment of a distinguished Belgian scholar, a perfect master both of English and of his own language, to whom I sent Vallancey's specimens for examination, and who assures me that there is nothing whatever in them which can be regarded as peculiarly Flemish.

I venture, therefore, to conclude that the Barony of Forth language is a lineal descendant of the English introduced by the first settlers, modernized in its forms, and also, though in a less remarkable degree, in its vocabulary. The latter, indeed, were it not for the large proportion of Irish words which it contains, does not depart very much further from the ordinary English than some of the provincial dialects of England themselves.

A more curious task would be to compare the Forth language with the Gower dialect, or with the popular language of south-west Pembrokeshire, of which the Forth settlement was but a colony, and which, if any inference could be drawn from the affinities of race, ought to be presumed to exhibit the same substantial characteristics. I regret my inability to undertake such a comparison; but I am confirmed, in what I have said of the Forth dialect, by Mr. Latham's opinion, that there is nothing peculiarly Flemish in the kindred dialect of Gower. The only specimen of the Gower dialect with which I myself am acquainted, is the short vocabulary published by Mr. Collins in the *Transactions of the Philological Society.*[11] It contains about sixty words; these, with the aid of my friend, Mr. Edmund Hore, I have compared with the Forth vocabulary; but there are no more than six out of the entire which we were enabled to identify; nor in these is the coincidence very remarkable, as some of them occur in other provincial dialects.

Nevertheless, I cannot help thinking that this curious dialect, even as bearing on the history of the English language, deserves more attention than it has received. It appears to me to partake of the vocabulary of each of the three great English provincial groups—the Northumbrian, the Mercian, and the Saxon, but especially of the last. Moreover, judging from the inflexions of the verb, and from the participial forms, it seems to me to belong to a period especially requiring illustration. And while I am fully conscious of my own inability to do justice to the inquiry, the meeting of the Association in Dublin has appeared to me an occasion on which I might venture to invite to it the attention of others whose studies in English philology will render the task at once easy and interesting.

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[11] A paper on the Flemings in Pembrokeshire in the "Archæologia Cambrensis", New Series, i., 138–42, contains nothing on the language.